Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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The PRACTICAL ENGINEER and ELECTRICIAN

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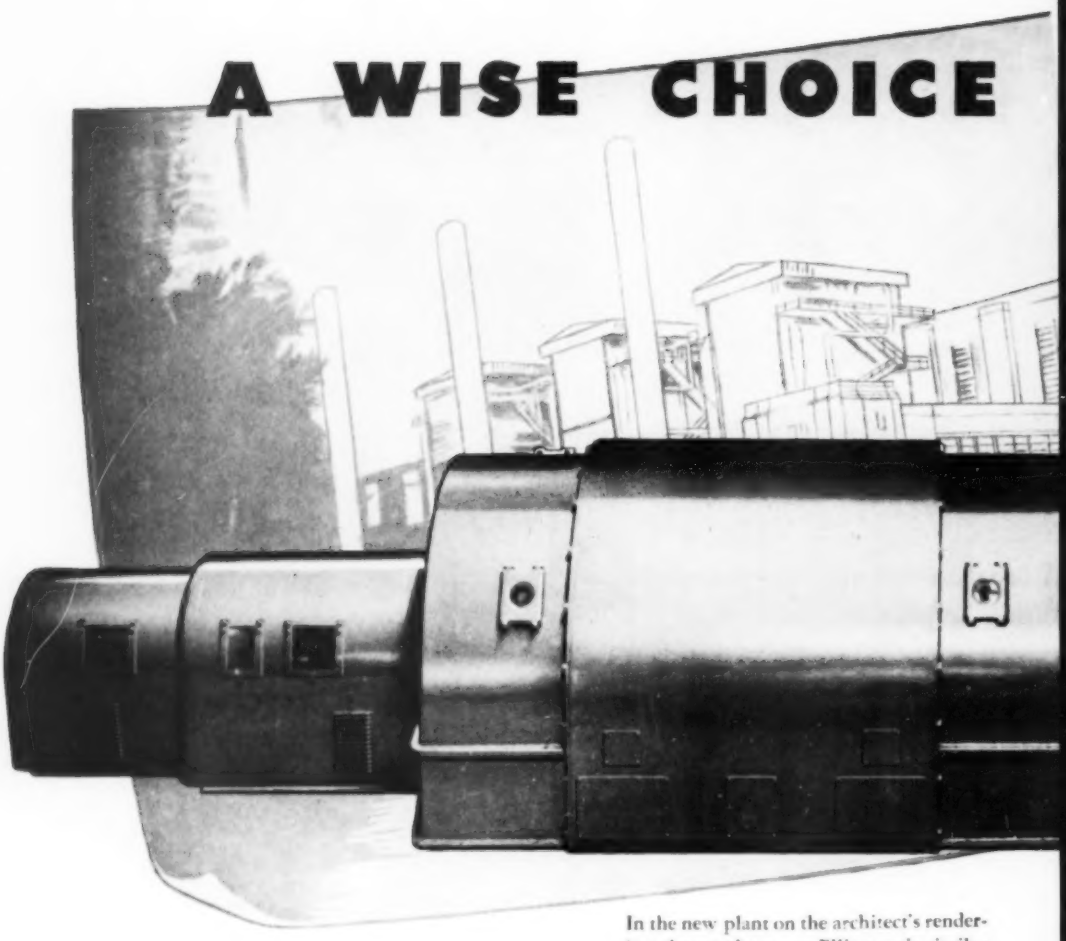
JUNE 1950

TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

A WISE CHOICE



In the new plant on the architect's rendering shown above, an Elliott unit similar to the one pictured is now in service, with a duplicate unit on order. On the opposite page, the drawing shows another new plant which will house three Elliott turbine-generators — one of 11,500 kw, the other two of 7500 kw each.

ELLIOTT COMPANY

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by ELLIOTT

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A new station gets off on the right foot for a long and successful career, when Elliott turbine-generators are selected as its basic equipment.

H-727

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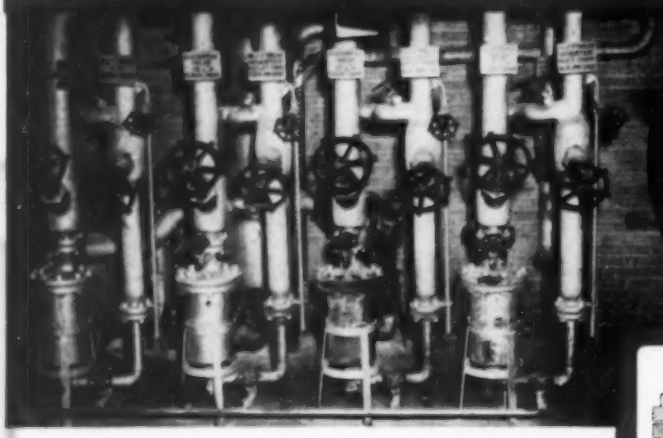

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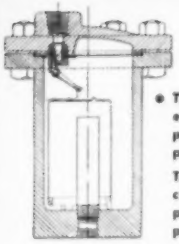

● **Traps with screwed connections for pressures to 900 psig.**

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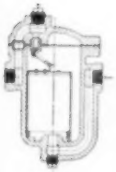

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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June 1950

VOLUME 54—NUMBER 6

Notes on This Issue

Entropy-Balance Spotlights Steam Power Losses

Here is a brand new conception for a diagram derived from the heat balance diagram but showing something entirely different. It is the entropy-balance diagram and it comes from the famuos turbine engineering division of General Electric through a paper by Allen Keller. This diagram shows exactly where energy is lost at each point in the steam cycle. It is based on the well known principle that every loss is accompanied by an increase in entropy, hence, if you can measure the entropy between any two points in the cycle, you know there is a loss there, and this diagram enables you to calculate it.

How Filming Amines Prevent Steam and Return Line Corrosion

This type of corrosion has been one of the most baffling problems power engineers have had, especially in industrial plants and large heating plants. The chief cause of the corrosion is carbon dioxide (CO_2), which may be formed by chemical reactions.

So far, one of the most effective ways of preventing steam and return line corrosion from CO_2 is by use of neutralizing amines, which keep the steam and condensate as neutral as possible. The new method described here uses a different type of amine that deposits a non-wettable film on the interior of the piping, resists both CO_2 and O_2 corrosion and costs only 10 to 40 per cent as much as the previously-used amines. Data to substantiate these claims, from over 50 actual plant installations, are given in the article.

Dual Fuel Engines at La Junta

The Municipal Lighting Plant at La Junta, Colorado, built in 1940, has an excellent record for economy of operation. A year ago, one of the 1750-hp diesel engines was converted to dual fuel operation and the operation of this engine has been so successful that a program has been started to convert all the other engines in the plant to dual fuel operation. The conversion is expected to save $50,000 a year in the fuel costs.

Single-phase 120/240-volts from a Three-phase Source

Ever since three-phase power supply systems were developed, the supply of single phase loads from such three-phase supplies has presented a problem to electricians and engineers in charge of such systems.

In the case of small loads, it is simple enough to tap one of the phases since the amount of unbalance created is not important. Where large single-phase loads are concerned, however, the problem becomes difficult and in the past several methods have been worked out which while practical necessitated the use of very expensive transformers.

Now, with the development of the modern load center unit substation, a simpler method has become available and this article describes three methods using such unit substations.

Proper Suction Intakes Vital for Vertical Circulating Pumps

The column-type or vertical condenser circulating pump has become increasingly popular with power plant designers during the past ten years.

One of the things that has been discovered about the vertical circulating pump is the absolute necessity for providing a correctly designed suction intake for it. If this intake arrangement is not properly designed, cavitation of the pump may result. Also, if the water flowing into the pump is pre-whirled in one direction or the other, it will effect the pump capacity adversely.

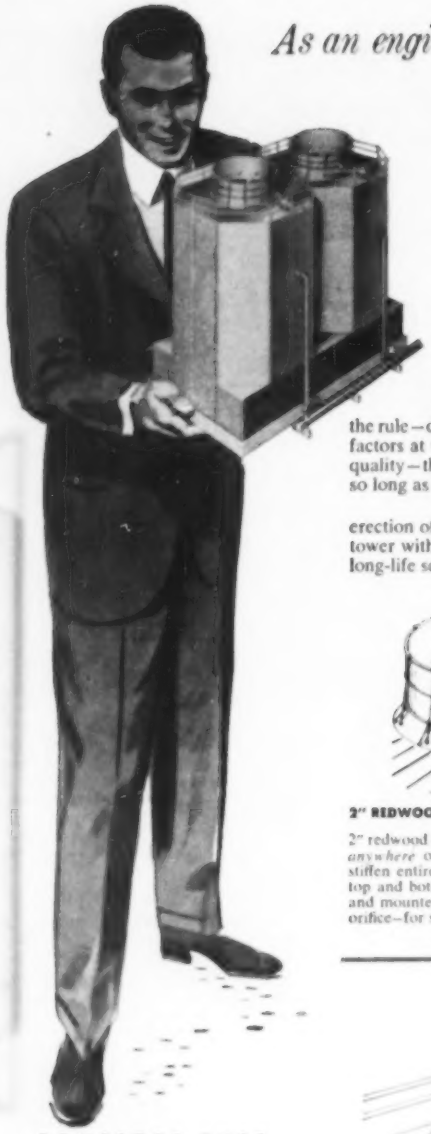
The author explains all these things and then gives the details of a test on a typical large circulating pump with curves and data that show how the shape, dimensions, submergence, use of splitters and other factors affect the pump.

El Centro Steam Station

This is the first published description of a very interesting power station, The El Centro Steam Station of the Imperial Irrigation District. It is located just above the Gulf of California, built on the silt brought down by the Colorado River. This required very special foundations.

As an engineer you will appreciate...

The RUGGED DESIGN inherent in the 1950 FLUOR COUNTERFLO Cooling Tower

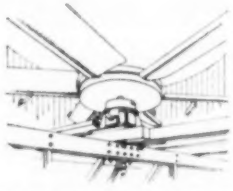


Ruggedness is a prerequisite in cooling tower design and performance. Without it, inefficiency and costly maintenance becomes the rule—drop in plant production is the end result. Regardless of the influencing factors at time of purchase—low first cost, claims of efficiency or statement of quality—the cooling tower you select will meet performance requirements *only* so long as its original structural design endures.

Thirty years' intensive development in the design, fabrication and erection of cooling towers enables Fluor to offer you a better cooling tower—a tower with comparable first cost, the highest obtainable efficiency and rugged, long-life service.

2" REDWOOD IN FAN DECK and STACK

2" redwood supports 1000#/sq. ft. load *anywhere* on deck—heavy enough to stiffen entire structure. Stack is ringed top and bottom with heavy angle iron and mounted on a metal bell-mouthed orifice—for safety and savings in power.



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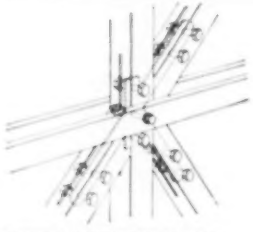

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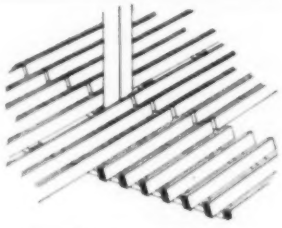
Internal gusset plate and bolt-type joints enable structural members to take *both* tension and compression loads—a design *in accordance* with the rigid requirements of major city codes and recent findings of the U. S. Forest Products Laboratory.



1" REDWOOD GRID DECK FILLING

Grid decks consist of heavy 1" redwood nailed individually on sturdy cleats—strong enough for use as scaffolding during tower erection, durable enough to permit repeated removal for cleaning or fire hosing without removing from tower.

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about
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For your protection compare the probable performance of the towers offered before making a decision. Analyze your cooling tower bids thoroughly!

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ENGINEERS' PREVIEW

FIRST TEN technical graduates have reported at Hanford Works in the state of Washington, to begin the newly-installed General Electric Co. rotational training program, believed to be the first program of its kind at any US atomic energy plant. Approximately 50 promising young technical graduates at a time ultimately will receive training through this latest innovation in personnel recruiting and training for work in the nation's atomic energy program.

★ ★ ★

AT A TIME when science is prized for its contributions of instruments and weapons, of food and health and physical power and comfort, I would remind you that the pleasures which come from an understanding of the beauties and forces of nature is a subtle value of science which extends the horizons of our intellect and enriches our lives—Detlev V. Bronk in the *Industrial Bulletin*.

★ ★ ★

AN INTERESTING new method of cooling, developed as a result of the extremely high operating temperatures of jet engines, has been reported. In the new system, the cooling liquid is forced through a porous powder part in a direction opposite to the heat flow.—*The Ohmite News*.

★ ★ ★

HAS YOUR LIFE ever been saved by a hard hat? If so, you might be interested in joining The Turtle Club, composed of men and women who have the common experience of having their lives saved by hard-hat wearing. Their object in thus banding together is to demonstrate the necessity of head protection against the ever-present risk of overhead hazards in industry. If you are interested, application blanks and full details may be obtained from E. W. Bullard of E. D. Bullard Co., 275 Eighth Street, San Francisco.

★ ★ ★

HIGH-SPEED camera for photographing the tell-tale interior of the eye is now in production. Developed after two years' research by Bausch & Lomb Optical Co., it photographs—in color or black and white—the retina, nerve fibers and other structural elements of microscopic size within the inner recesses of the eye. It is used for studies showing the relationship between enlarged retinal blood vessels and such vascular diseases as high blood pressure and arteriosclerosis; in diagnosing and treating glaucoma, which causes 12 per cent of all blindness; in revealing certain systemic diseases as arteriosclerosis, diabetes, hypertension, nephritis, and tumors of the central nervous system which are evidenced by changes in the retina long before the appearance of clinical symptoms.

★ ★ ★

NOW THAT the country has passed through another paroxysm of seeing spots before its eyes in the form of flying saucers, it may be of interest to point out that, according to a recent newspaper report, some "theoretical scientists" at one of the country's famous schools of technology have submitted a highly theoretical report on them.

After examining a non-existent piece of wreckage that hadn't arrived, the scientists pronounced: "It contained mendacium, assininium and irium, as well as the irium derivative, del-irium." Well—maybe so—maybe not.

SUGGESTIONS are now coming from various quarters that perhaps the railroads of the country are overlooking a good bet if they do not take up again some of the ideas they have had in previous years about electrification of their lines. There are two principal reasons for taking them up again. One is that the rectifier has developed so that it could solve many of the problems of rotating conversion and provide a railroad locomotive with d-c traction motors on its axles and pantographs on its roof making contact with 60-cycle catenary. The second reason, as the *Electrical World* points out, is that today our electric power transmission systems are so extensive that the railroads could connect into them at almost any point to obtain the necessary power.

A good illustration of what this means was the electrification plan adopted for the Big Inch and Little Inch pipe lines. On these, the transmission lines of the utilities were tapped at frequent intervals wherever necessary to establish pumping stations on the pipe line and no parallel transmission lines were necessary. Similarly, power lines can be made available or are already available wherever electrified railroads want to go. The railroads might need to provide only a little more than feeder and trolley, while poles might be used instead of heavy catenary towers. Many of these items were discussed by A. C. Monteith of Westinghouse recently before the New York Railroad Club. More on this in a subsequent issue.

★ ★ ★

CLOSING DATE of the nationwide survey of selected engineering personnel sponsored by the Engineers Joint Council for the U. S. Office of Naval Research, has been advanced to July 15, 1950. Intended to serve as a file of key engineers working in research, development and other scientific projects who can be called in on a full or part time basis to work on the broad scientific programs of the National Military Establishment, the survey was originally scheduled to close on March 15. Thus far, however, only two thirds of the 115,000 questionnaires sent out have been returned by the engineers.

Since the omission of such a large segment of the engineering profession from the proposed file will seriously limit its usefulness, the Office of Naval Research has authorized the mailing of a third reminder.

The questionnaires are being processed by the ASME contracting agent under an ONR agreement. The survey is managed by the EJC Committee. C. E. Davies, secretary of ASME, is chairman and R. A. Wentworth, member of ASME, is survey director.

★ ★ ★

NEW MICROWAVE COMMUNICATIONS relay system 400 miles long will be furnished by Philco Corp. to supply The Humble Pipe Line Co., Houston, Texas. This new communications system for Humble will parallel that company's pipe line facilities from Houston to Kemper, Texas, and will initially provide eight voice circuits and a combination of teletype, telegraph and telemeter circuits. Operating at frequencies of about 7,000 megacycles—at wavelengths shorter than a cigarette—this new microwave equipment can readily be expanded to handle 32 voice channels, thus enabling the pipe line company to take care of an additional volume of communications.

NEW WONDER PLAY TOY for scientists is carbonyl iron powder, produced by General Aniline. It is used as a pharmaceutical to treat anemia, is added to white flour to build up iron content in bread, in its liquid state is an antiknock agent for gasoline and, mixed with an electric current added, can become as rigid as a metal shaft for driving mechanisms. When you handle it, moreover, it feels like talcum powder.

★ ★ ★

MOST BUSINESS executives have found that sound policy decisions require both accurate information and mature judgment. To help businessmen in making such decisions, Arthur D. Little, Inc., has built up a staff of professionally trained men experienced in economic appraisal. The services this staff offers are described in a folder recently issued by the company. They include analysis of diversification and growth, distribution policy, revitalizing product lines, studies of potential markets, market effectiveness, studies of product acceptance, selection of plant sites, project soundness and regional development. The folder may be obtained from Arthur D. Little, Inc., 30 Memorial Drive, Cambridge 42, Mass. As every reader of the *Engineers' Preview* should know by this time, Arthur D. Little, Inc., is the company that issues the famous *Industrial Bulletin* containing interesting accounts of modern research developments and their applications in industry. We quote frequently from this bulletin.

★ ★ ★

FIRST APPLICATION of its Vigilarm fire detection system to rotating machinery has been reported by the Gamewell Co. In the successful adaptation by a west coast public utility, it is said to help effect control in five to ten seconds of flash-over fires in giant power-house generators.

The system operates when there is abnormal temperature rise. It automatically releases water-fog or carbon dioxide extinguishing agents when temperature exceeds a pre-determined safety point in the generators. Expanded air in the tubing operates extinguishing devices in a fraction of time said to be required by fixed temperature thermostats.

Extensive tests by the public utility on specially-built "mock-up" generators indicated there now would be little harm to expensive electrical windings, in event of flash-over fires.

★ ★ ★

NEW RAYON SPINNING and processing machine has been invented by H. A. Kuljian, which, he asserts, will reduce the time of the production on rayon yarn from three to four days to three and one-half minutes. Mr. Kuljian is familiar to power engineers as the head of a consulting engineering and construction firm, the Kuljian Corp., which has designed and built many outstanding power plants. Mr. Kuljian spent a number of years in the rayon industry with American Viscose Corp., from which he resigned twenty years ago to found his present company. His new rayon making machine produces finished yarn from a viscose solution in three and one-half minutes by a continuous process under which the yarn is spun, regenerated, desulphurized, bleached, dried, twisted (if desired) and finally packaged on a spind'e in one continuous operation. Mr. Kuljian states that the machine will sell for about $500 and can produce all types and thicknesses of rayon yarn up to the 1150 denier used in tire cord yarn. He claims his machine will save 10 to 15 cents a pound on the manufacturing cost of rayon yarn.

POSTWAR HEAT TRANSFER development will be the theme of an international discussion to be held in London, September 11th to 13th, 1951. Plans for participation by engineers in the Western Hemisphere are being arranged by the Joint Committee on North American Participation, which consists of representatives from a large number of national engineering and scientific societies. The American Society of Mechanical Engineers, 29 West 39th Street, New York, is coordinating administrative details.

Preliminary plans indicate that the following subjects will be among those discussed: Recent information on physical properties of gases and gas mixtures pertinent to their heat transfer characteristics; Measurement problems related to heat transfer; Mass transfer and heat transfer; Heat transfer by sweat and film cooling; Condensation at high speed flow; Heat transfer to liquid metals; The analogy method for the solution of conduction problems.

★ ★ ★

AT PRESENT PRICES, there is little chance of research developing a manufactured gas from coal which can compete directly with natural gas, scientists from Battelle Memorial Institute have declared.

Speaking on the "Economic Aspects of the Development of Fuel Gas From Coal" at a meeting of the AIChE, Dr. John F. Foster, Battelle fuels expert, and Dr. Richard J. Lund, authority on engineering economics, said that delivered wholesale prices of natural gas would have to double, at least, before science can produce from coal a fuel gas that would be competitive. Likewise, they see little chance of manufactured gas competing with fuel oil at present price levels.

Their study gives support to the current view among technologists and persons associated with the coal industry that the promotion of the use of electricity is one of the best means for coal to maintain and expand its markets. Dr. Clyde Williams, director of Battelle, suggested this to the National Coal Association last fall, and recently there has been a revival in interest in railroad electrification and other heavy uses of electrical current.

★ ★ ★

NEPHELOMETRY is a science but don't try to guess from the name what it might be the science of. No, it is not a science having anything to do with nephews nor anything to do with nephritis. We can't keep it from you any longer—nephelometry is the science of measuring the appearance or the concentration of extremely dilute suspensions—that is, particles suspended in a solution when the dimensions of these particles are far below the sizes that can be observed with microscopes. The principles on which nephelometry is based are not by any means new. They were developed by the British scientist John Tyndall 'way back in the 1880's and 1890's. He devised methods of using light beams to make the particles visible and used them in what was then an ultra-microscope. A great deal has been learned about this subject since that time and recently some new types of nephelometers employing photo-electric devices and precision measuring circuits have been developed. Nephelometry is very useful in studying early stages of growth of bacteria in cultures, materials suspended in beverages, boiler water and condensate, oil, plating baths or plastics. The science has proved very valuable in such diversified fields as water treatment, confectionery, whiskey rectification, tanning, filtration and flotation control.

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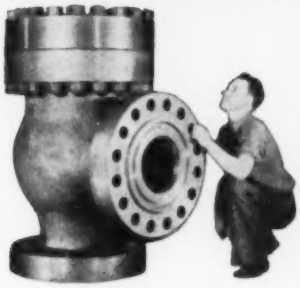
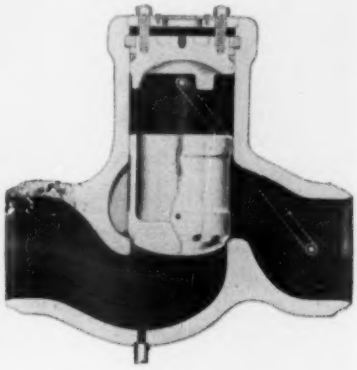
BIG CHECKS

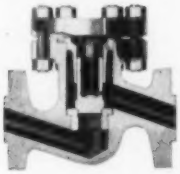


Vibration, clatter and damaging shock to piping are eliminated with Edward piston-type check valves. Integral guide ribs, cored out for free flow, guide the hourglass disk-piston throughout travel to prevent hanging up. New flow contours reduce pressure loss, increase operating efficiency. Built in sizes through 14 in.



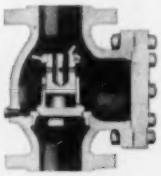
AVAILABLE IN HORIZONTAL ~ . . . ANGLE ⌐ . . . VERTICAL |

MEDIUM



Exclusive Edward disk guide lip aids tight seating and cuts wear on seat and disk through momentary throttling action.

Edward check valves may be disassembled without removing from the line. Covers are forged steel.



AVAILABLE IN HORIZONTAL ~ . . . ANGLE ⌐ . . . VERTICAL |

SMALL

Edward forged steel check valves are spring loaded to insure quick, accurate seating. Bodies are streamlined.

For viscous fluids or hydraulic service, Edward ball checks are ideal. Stainless steel ball is mated to seat.

Design of small Edward checks permits use in either horizontal or vertical lines. Built in sizes down to ¼ in.

AVAILABLE IN HORIZONTAL ~ . . . ANGLE ⌐ . . . VERTICAL |

Another Product

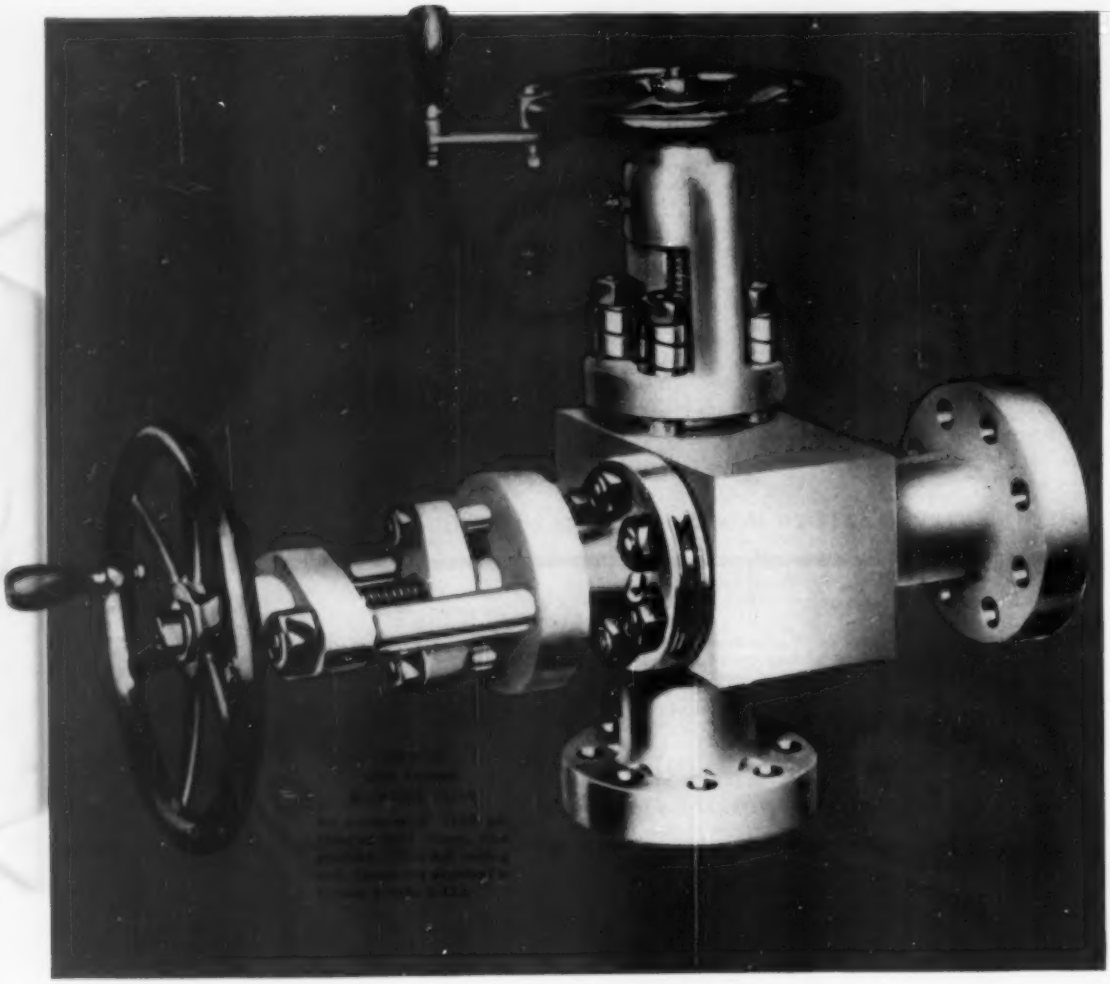
Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

A REQUEST ON YOUR COMPANY LETTERHEAD WILL BRING EDWARD CATALOG No. 103

YOUR BOILER



YARWAY

IS WORTH A *GOOD* BLOW-OFF VALVE

Boilers represent sizable investments . . . certainly worth protecting with the most dependable boiler trim you can get.

You need good blow-off valves—valves that keep blow-down lines tight, don't wear, clog or leak, and are rugged enough to stand up under the severe shock of regular or emergency blowing-down under pressure.

Yarway Blow-Off Valves meet those requirements. Both Yarway Seatless Valves with balanced sliding plunger, and Yarway Stellite-faced Hard-Seat Valves embody the most recent developments in design and metallurgy.

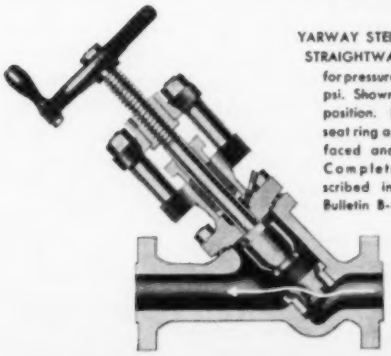
Engineers tell us the sturdiest of all blow-off valves is the Yarway Unit Tandem. This famous valve combines either a seatless and hard-seat, or two hard-seat valves, in a one-piece forged steel body. It is made for pressures up to 2500 psi. Other Yarway Blow-Off Valves meet lower pressure requirements.

It is significant that more than 15,000 plants throughout the world use Yarway Blow-Off Valves . . . and among the higher pressure plants, 4 out of every 5 are Yarway-equipped!

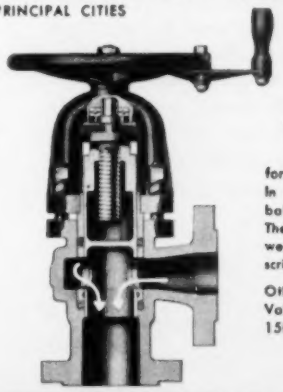
A Yarway bulletin will tell you in detail how these valves can protect *your* boiler investment. Write today, stating pressure range.

YARNALL-WARING COMPANY, 114 Mermaid Avenue, Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES



YARWAY STELLITE-SEAT STRAIGHTWAY VALVE for pressures to 2500 psi. Shown in open position. Disc and seat ring are stellite-faced and ground. Completely described in Yarway Bulletin B-432.



YARWAY TYPE "B" SEATLESS ANGLE VALVE for pressures to 400 psi. In open position. Notice balanced sliding plunger. There is no seat to score, wear, clog or leak. Described in Bulletin B-424.

Other Yarway Seatless Valves for pressures to 1500 psi.

Doesn't this describe the boiler you want?

- **Designed for industrial load conditions, particularly for plants having small operating and maintenance forces**
- **Offers special design and construction features that assure low annual operating costs**
- **Suitable for a wide choice of fuels and firing**
- **Service-proved in plants similar to yours**

High ratio of radiant heating surfaces . . . fully water-cooled furnace . . . amply insulated steel casing . . . easily accessible tube banks . . . feature after feature of the Vertical-Unit Boiler, Type VU-10, assure top performance with low operating and maintenance costs throughout the lifetime of the equipment. Moreover, because of its symmetrical design every foot of boiler width handles the same amount of water, is swept by the same quantity of gas, and thus absorbs the same amount of heat. This assures uniform steam release, uniform water level across the boiler drum and uniform expansion of pressure parts. It accounts, too, for the ability of the boiler to handle rapid load swings and to produce satisfactory steam quality at all ratings.

The VU-10 is a compact unit, available in sizes which provide capacities from 10,000 to 60,000 lb per hr. Its adaptability to various fuels and methods of firing is emphasized by the fact that the five types of firing illustrated on the opposite page are all applicable to the same general boiler and furnace cross-section. Thus the VU-10 permits you to choose the one *best* method of firing for the fuel and load conditions of your plant.

The Vertical-Unit Boiler has made an outstanding record in meeting the widely varying requirements of plants in virtually every branch of industry. A partial list of the industries that have selected the VU-10 is shown below. The chances are that some plant – or plants – with operating conditions similar to yours are now profiting from VU-10 performance. Let us suggest one in your locality where you can make your own check.

B-399

PARTIAL LIST OF INDUSTRIES THAT HAVE SELECTED THE VU-10 BOILER

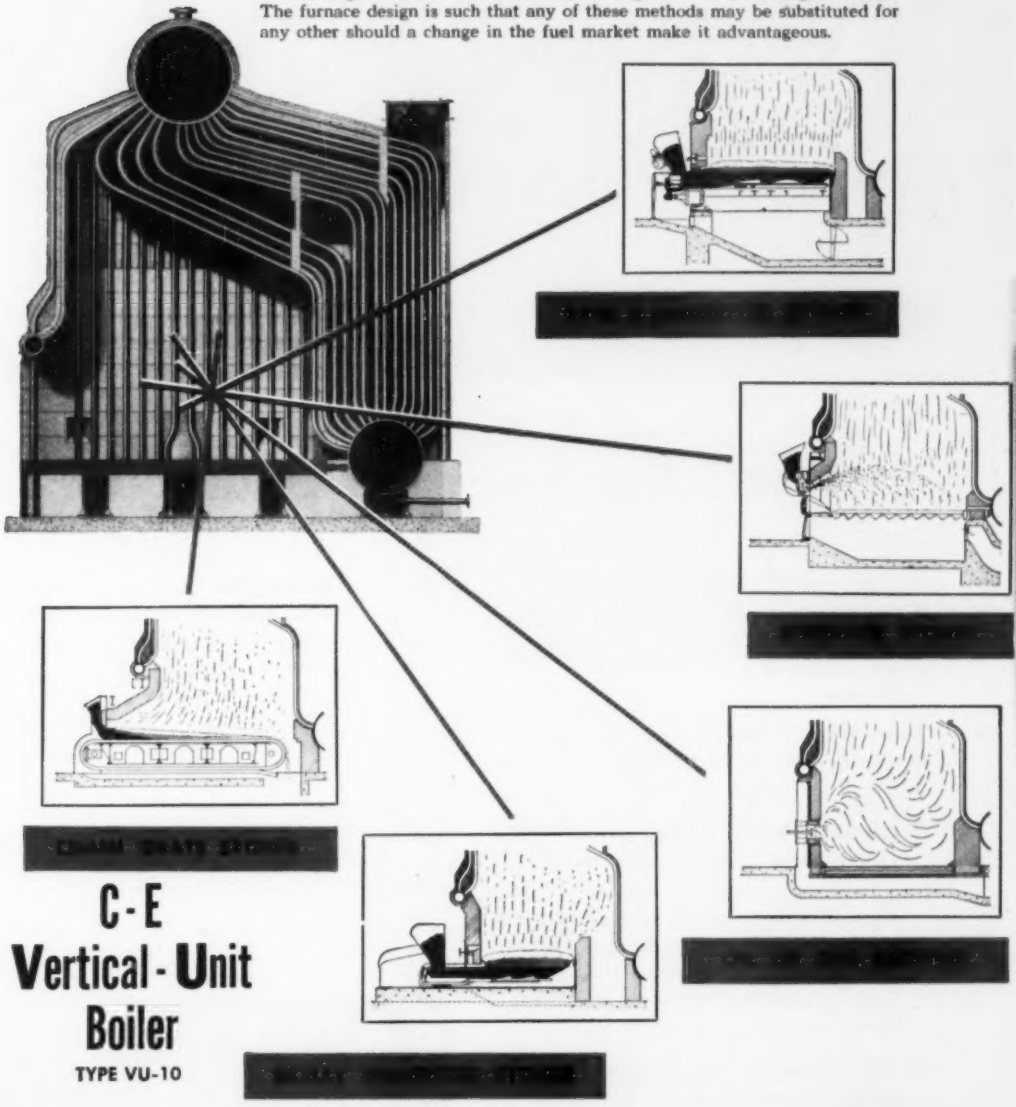
AUTOMOBILE	COLD STORAGE	HOSIERY	LINOLEUM	PAINT	STEEL
BAKERIES	DAIRIES	HOSPITALS	MACHINERY	PAPER	SUGAR
BREWERIES	DISTILLERIES	INSTITUTIONS	METALS	RAILROADS	TEXTILE
CEMENT	FOOD	LAUNDRIES	OIL	RUBBER	TOBACCO
CHEMICAL	GLASS	LEATHER	PACKING	SCHOOLS	UTILITY

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

For every fuel market and every type of load there is *one best* method of firing. The selection of that *one best* method for the fuel and load conditions of a particular plant calls for judgment based on broad experience and free from any incentive to favor one type of equipment over another.

The Type VU-10 Boiler is designed for five methods of firing—spreader stoker, single-retort underfeed stoker, chain grate stoker, oil or gas burners. The furnace design is such that any of these methods may be substituted for any other should a change in the fuel market make it advantageous.

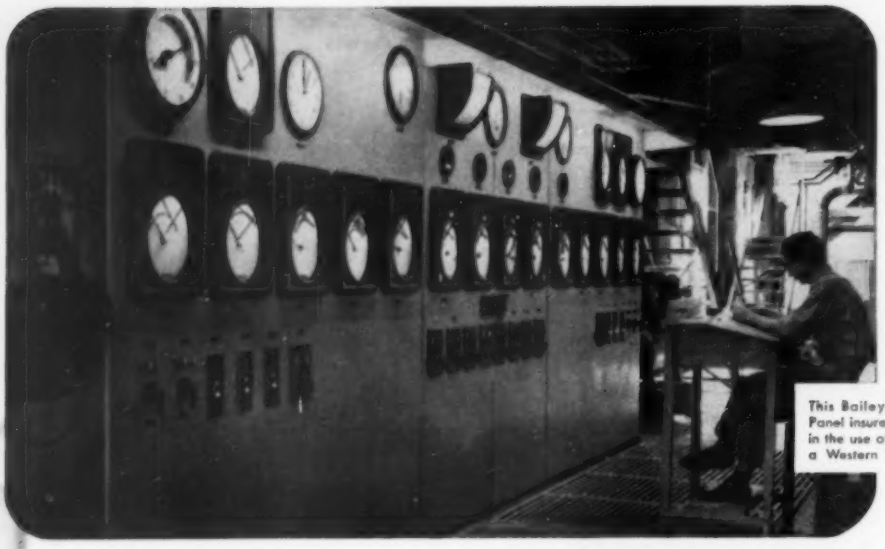


C-E Vertical-Unit Boiler

TYPE VU-10

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.



This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

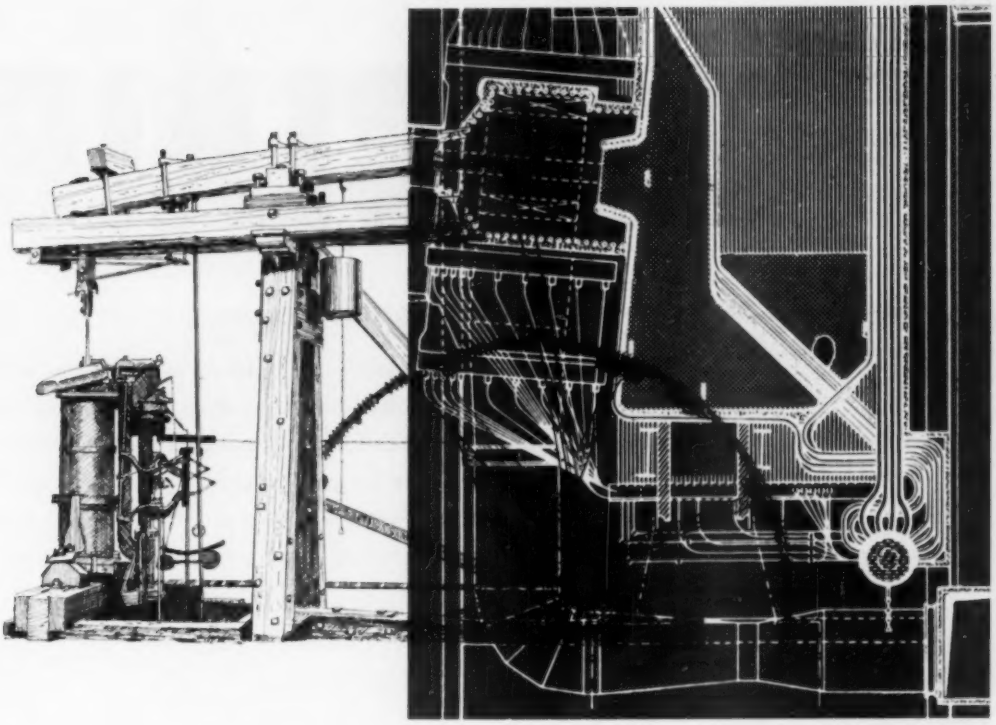
BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

Watt would be horrified!



The condensing steam engine of James Watt made modern industry possible. Until he died in 1819, however, Watt argued stoutly that steam should be used only at a few pounds above atmospheric pressure. What would he think of central stations generating steam at pressures up to 2500 psi—or even of industrial power plants using today's "low" pressure of 400 psi?

Watt never thought of worrying about the water converted into steam for his engine. Today, high pressure, high temperature, and high rating make the conditioning of boiler water a complex problem in chemical engineering. In one plant, precision control of phosphate and silica at levels of only a few ppm may be the most economical way of simultaneously keeping sludge off tube surfaces and silica off turbine blades. In another, better clarification of raw water may be the most practical line of attack on a tough problem of complex silicate scale.

Hall Laboratories is equipped, through years of experience and continuing research, to deal with the almost infinite variety of cross-relationships presented by modern boilers—and also to advise on all other industrial water conditioning problems. A copy of the new Hall Bulletin "Your Most Important Raw Material" is yours for the asking.

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pennsylvania.

HALL *plant-wide* WATER SERVICE

BOILER WATER CONDITIONING

PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

A turbine oil

SINCLAIR

Cats seem to live a charmed life. And in many ways so do Sinclair SINTURLITE Oils! You'd expect the grueling conditions of turbine service to cut short the life of any oil. But SINTURLITE is different!
Not just for months—but for years—SINTURLITE keeps right on lubricating efficiently . . . resisting oxidation, retarding sludge formation, preventing rust, separating readily from water. Long serv-
RESISTS OXIDATION
PREVENTS RUST
For lubrication counsel, see your nearest Supplier of Sinclair Products or write to Sinclair Refining Company, 630 Fifth Avenue, New York 20, N. Y.
SINCLAIR

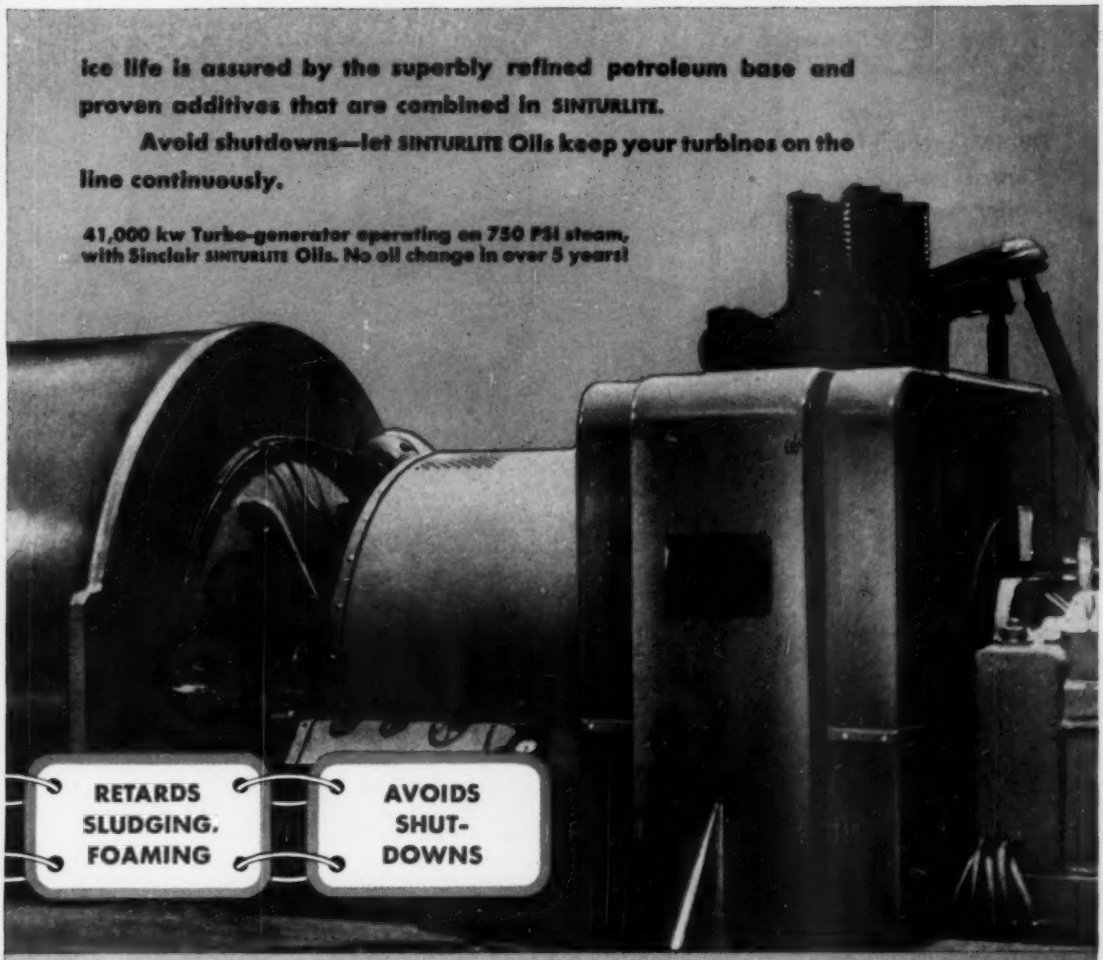
with nine lives...

SINTURLITE

ice life is assured by the superbly refined petroleum base and proven additives that are combined in SINTURLITE.

Avoid shutdowns—let SINTURLITE Oils keep your turbines on the line continuously.

41,000 kw Turbo-generator operating on 750 PSI steam, with Sinclair SINTURLITE Oils. No oil change in over 5 years!

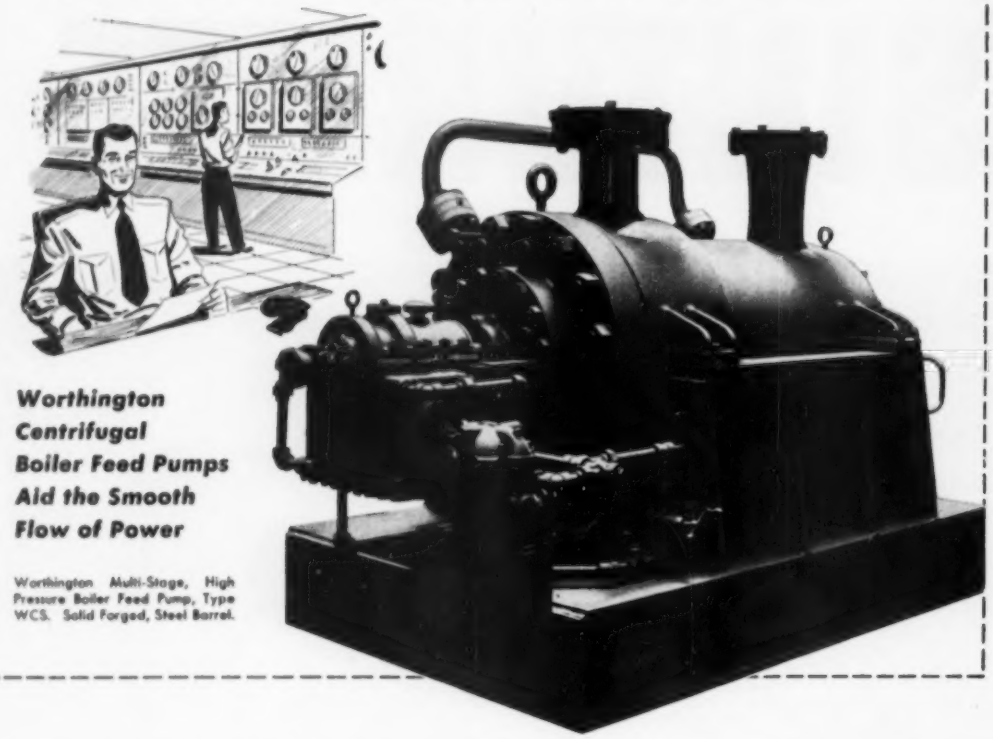


RETARDS SLUDGING, FOAMING

AVOIDS SHUT-DOWNS

INDUSTRIAL OILS

HERE'S DEPENDABILITY
your power dispatcher will appreciate!



Worthington Centrifugal Boiler Feed Pumps Aid the Smooth Flow of Power

Worthington Multi-Stage, High Pressure Boiler Feed Pump, Type WCS. Solid Forged, Steel Barrel.

Your Power Dispatcher knows that to keep the kilowatts flowing out of the switchboard, smoothly and without a break, the boiler feed pumps must be in there pitching every minute.

To produce the most reliable and economical boiler feed pumps calls for highly specialized knowledge . . . of materials, to select the finest developed by modern metallurgy . . . of correct design, based on actual field experience . . . and of application, to fit the *right* pump to the job.

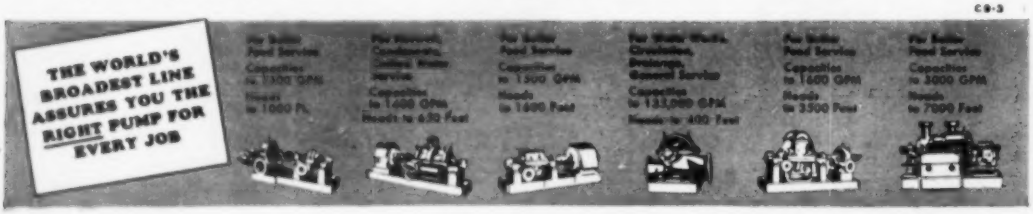
That's why control room men everywhere are grateful for the year-in and year-out dependability of Worthington Centrifugal Boiler Feed Pumps . . . and why more and more Central Stations are finding complete pumping satisfaction in these smooth-working aids to low cost trouble-free power production.

THE WORLD'S WIDEST CHOICE

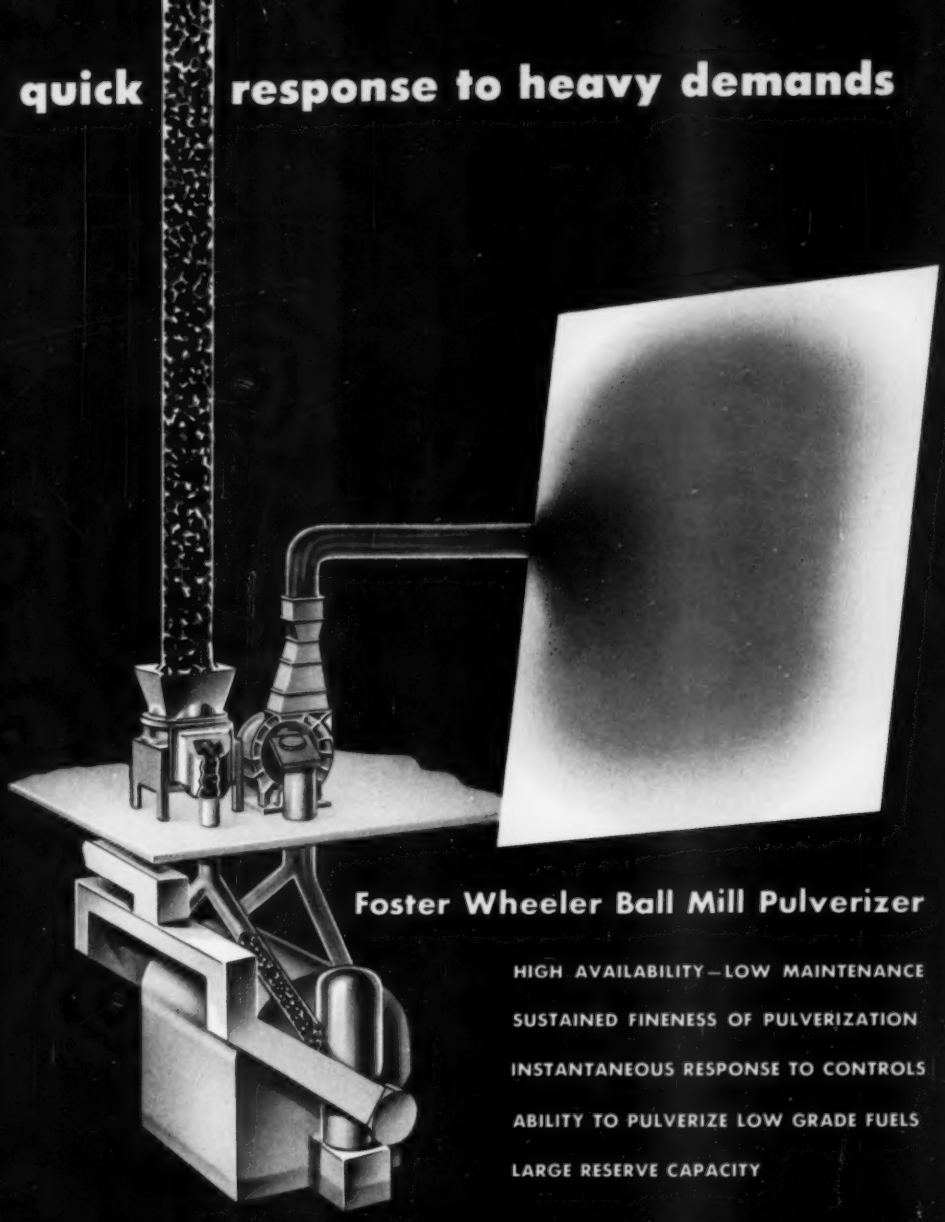
is yours in Worthington's most complete line of Centrifugal Pumps. You can count on Worthington's expert engineering staff for valuable aid in choosing just the right size, pressure and capacity . . . still further proof of the *more worth in Worthington*. Call our nearest District Office, or write to: *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

WORTHINGTON

C9-3



quick response to heavy demands



Foster Wheeler Ball Mill Pulverizer

HIGH AVAILABILITY—LOW MAINTENANCE

SUSTAINED FINENESS OF PULVERIZATION

INSTANTANEOUS RESPONSE TO CONTROLS

ABILITY TO PULVERIZE LOW GRADE FUELS

LARGE RESERVE CAPACITY

The basic qualities of dependability, responsiveness, and capacity for hard work . . . as symbolized by the prize workhorse . . . are also desirable in modern machinery. But it is the added element — *skilled engineering* — that removes us so distantly from the horse age and makes it possible to build machinery like the Foster Wheeler Ball Mill Pulverizer which pulverizes as much as 30 to 40 tons of coal per hour with instantaneous response to load demands.

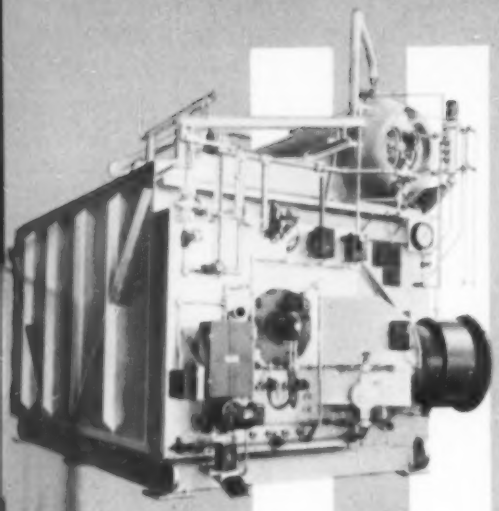
For further information write to

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

a small unit with a great background

FOSTER WHEELER PACKAGE STEAM GENERATORS



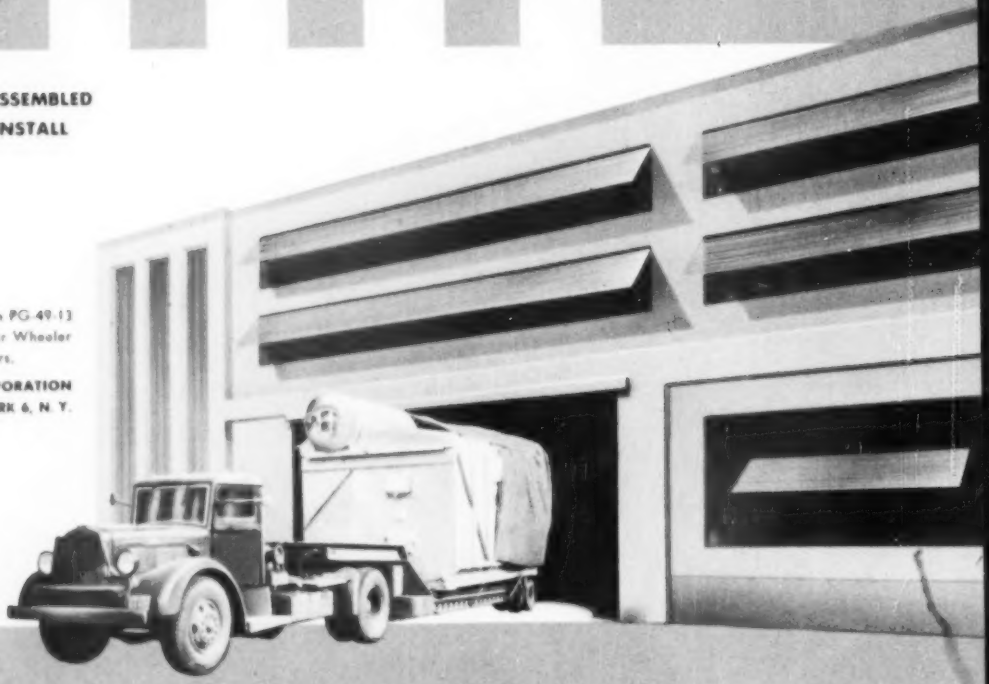
water-tube units embodying the best features of central station and industrial steam plants

The average boiler horsepower per unit of 15,000 installations which were surveyed recently lies between 150 to 175 hp. These units were found to be operating at extremely low efficiencies with poorly coordinated equipment. There was also evidence that erection had been done by unskilled or semiskilled labor.

Could one of these installations be yours?

Provide for your present and future steam plant requirements by installing a scientifically integrated Foster Wheeler Package Steam Generator which *insures continuous steam output under widely fluctuating load demands at low cost and with a minimum of maintenance.* Exclusive Foster Wheeler features affecting casing, combustion controls, insulation and general structure are incorporated in this unique package unit.

FACTORY ASSEMBLED
READY TO INSTALL



Write for a copy of Bulletin PG-49-13 covering all types of Foster Wheeler Package Steam Generators.

FOSTER WHEELER CORPORATION
165 BROADWAY, NEW YORK 6, N. Y.

FOSTER WHEELER

IT'S WHAT YOU DON'T SEE THAT

Cripples

POWER PLANTS!

You run the risk of lowered efficiency — even plant shutdown — when you fail to protect your power generation equipment against attacks of scale, embrittlement, carry-over and corrosion! The following Allis-Chalmers corrective chemicals, recommended and applied by specialized water-conditioning engineers, are available to solve all of *your* costly water and steam troubles.

AKON TREATMENT — An effective oxygen absorbent and sludge coagulant for boilers, either internally or externally treated.

AKON BRICKS — A solid composed of Akon treatment and softening chemicals for internal treatment in low to medium pressure ranges.

No. 26 INTERNAL TREATMENT — Used as oxygen scavenger and sludge dispersive agent for boilers, either internally or externally treated.

No. 30 SERIES — Powdered formulations combining all of the necessary softening chemicals with an organic dispersive material.

SILIMITE TREATMENT — Effective high magnesium dolomitic lime for silica reduction in connection with a hot process lime-soda softener.

No. 40 SERIES — Powdered formulations for scale and corrosion control as supplementary treatment for boilers in *all* pressure ranges.

No. 160 SERIES — A liquid formulation consisting of the volatile amines for corrosion control in condensate return systems.

No. 20 SERIES — Powdered formulations designed to control excessive scale and corrosion problems in plant cooling cycles.

No. 60 SERIES — Powdered formulations for inhibiting corrosion in brine and circulating water systems and low pressure boiler plants.

A-C ANTI-FOAM — An effective formulation to overcome damaging foaming in power plant boilers operating over 150 psig.

HENRY W. FINK, with over 10 years experience in power plant water conditioning, is one of the Allis-Chalmers specialists located around the country to advise you on correct water conditioning equipment, chemicals and service. For free survey, call your nearby Allis-Chalmers office.

FOR OVER HALF A CENTURY, Allis-Chalmers has been building power generation equipment. This experience provides our water conditioning specialists with the extensive background needed today to recommend, not only correct equipment, but chemicals and service as well.

Whatever your industry — paper, petroleum, food, steel — an expert Allis-Chalmers representative is available, ready to recommend proper chemicals or help select the right process for your power plant requirements. Get in touch with him today at your nearby Allis-Chalmers Office.

Akon and *Silimite* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

Water Conditioning

✓ EQUIPMENT ✓ CHEMICALS ✓ SERVICE

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

Gentlemen:

Please send me specific information on the following chemicals:

_____

_____

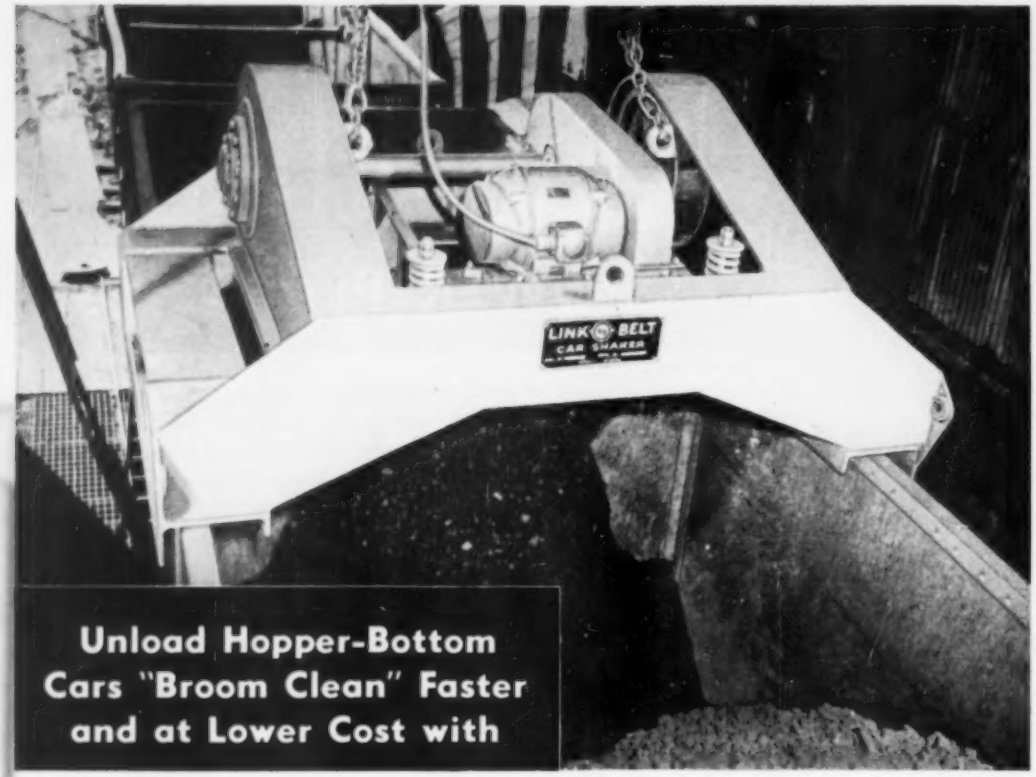
Name _____

Title _____

Company _____

Address _____

City _____ State _____ A-2983



Unload Hopper-Bottom Cars "Broom Clean" Faster and at Lower Cost with

LINK-BELT CAR SHAKER

THE ONLY CAR SHAKER WITH ALL THESE IMPORTANT FEATURES

POSITIVE ACTION—Lower vibrator speed results in positive impact action. Easier on cars. Vibration rate adjustable in the field for all types of coal and other bulk materials.

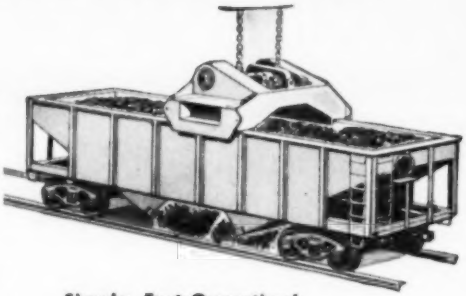
ELIMINATES OBJECTIONABLE NOISE—Low-frequency results in a relatively low sound level.

LOWER COSTS—Only 1 to 3 minutes required for "broom-clean" unloading of most cars. Especially effective for unloading damp or sticky materials.

LONGER LASTING, SAFE—Lower operating speed reduces wear and maintenance. Rugged construction. No picks or hammers needed. Less hazard to crew.

UNDIVIDED RESPONSIBILITY—Link-Belt can furnish, when required, the complete system, including shaker, hoist, frame, track hoppers, feeders and conveyors.

Check your present unloading methods against the dollar-saving efficiency assured by Link-Belt's exclusive features. Get full details on installation and application to your needs. Send for Book No. 2345.



Simple, Fast Operation!

★ Lower the Link-Belt Car Shaker to the top of car walls.

★ Start motor. Positive-action vibration on car sides and hopper bottoms does the job clean and fast.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices in Principal Cities.

In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

Your nearby TUBE TURNS distributor can serve you right from stock. Call him for prompt delivery.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY DISTRIBUTORS IN ALL PRINCIPAL CITIES

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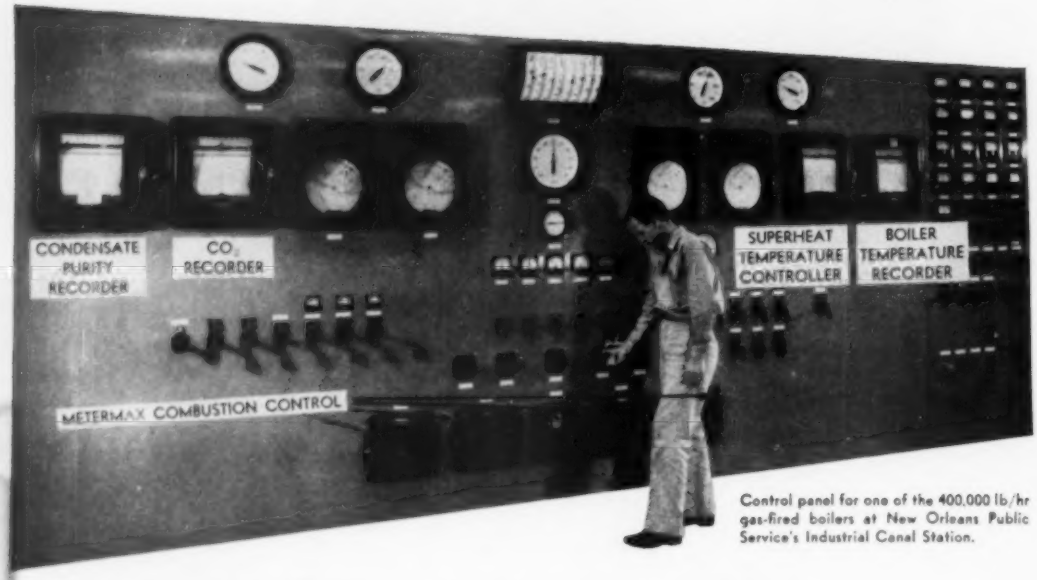
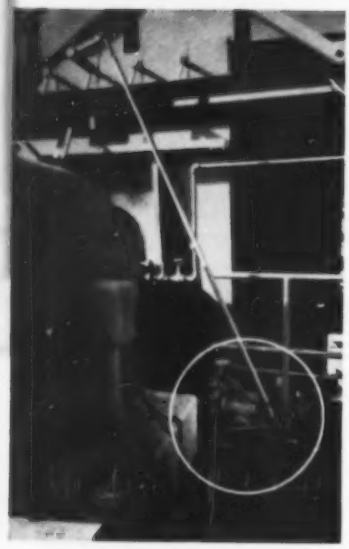
In Canada . . . Tube Turns of Canada Limited, Chatham, Ontario



Control panel for one of the 400,000 lb/hr gas-fired boilers at New Orleans Public Service's Industrial Canal Station.

From Btu's to megawatts—
L&N equipment aids plant efficiency



In this semi-outdoors plant, rugged Metermax Electric drive units, like this one (circled) on the induced draft vanes, operate dependably without need for protection from the weather.

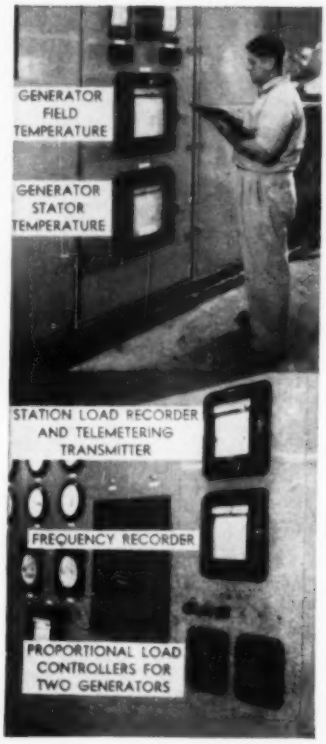
The new Industrial Canal Steam Electric Generating Station of New Orleans Public Service Inc. uses L&N instruments and controls at many steps in power production—from firing fuel to distributing power.

Steam-end equipment includes Metermax Combustion Control; Micromax Superheat Control; Micromax Recorders for temperatures of air, water and steam, CO_2, and for condensate purity. On the electrical end are recorders for temperatures of bearings and generators and for frequency, load telemetering and load-frequency control.

In addition to these, we supply the power industry with recorders for smoke density, pH, flow, a-c and d-c voltage and current, power factor and reactive kva.

If you'd like panel engineering service, we're equipped to design and build complete panels, shipped to you fully assembled, wired and tested, ready for installation.

For details, write to Leeds & Northrup Co., 4973 Stenton Ave., Philadelphia 44, Pa.


GENERATOR FIELD TEMPERATURE
GENERATOR STATOR TEMPERATURE
STATION LOAD RECORDER AND TELEMETERING TRANSMITTER
FREQUENCY RECORDER
PROPORTIONAL LOAD CONTROLLERS FOR TWO GENERATORS

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

WHAT CAUSES TUBE FAILURE?

When deposits are present, tube failure can usually be readily traced to the insulating effect of deposits on tube metal. The *proper* use of the *proper* water treatment will eliminate this problem.

In many cases, however, deposits are not present in failed tubes. Tube failure frequently results from mechanical action . . . poor circulation, steam blanketing, flame impingement, faulty design and similar troubles. In such cases, the cause of the failure often cannot be readily determined and careful investigation is required.

You can't overcome the problem if you don't know the cause!

The Drew System of Water Treatment eliminates guesswork. It starts with proper diagnosis. It includes recommendations for corrective treatment, and other preventive measures such as modification of operating cycles and redesign of equipment, if required. It is specialized service applied to your individual boiler problem.

Don't gamble with guesses! Consult the Drew Engineer or write for further information.

POWER DREW CHEMICALS

Power Chemicals Division

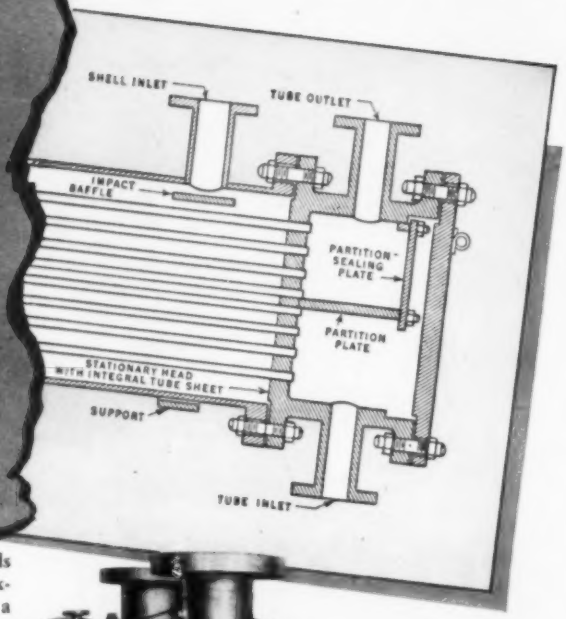
E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

Nationwide service in Boiler Water and Cooling Water Conditioning

DREW PRODUCTS

Leakage Between Passes Prevented in G-R FEEDWATER HEATER



The partitions between passes in the water heads of feedwater heaters are a fruitful source of leakage that can't be detected. The head cover is a literal "iron curtain" behind which you can't see short-circuiting of water between passes.

●

Griscom-Russell offers designs of feedwater heater stationary and floating heads in which this inter-pass leakage CAN'T occur. How? By making the differential in water pressure between the passes help to keep the partition joints *tight* instead of tending to force them apart.

●

The sketches tell the story. It's one of many instances of G-R pioneering in the design of feedwater heaters. Write for bulletin describing these heaters and their many distinctive features that give you benefits you can't obtain in other feedwater heater designs.

THE GRISCOM-RUSSELL CO.
285 MADISON AVENUE, NEW YORK 17, N. Y.

GR-201

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

THE TAPE THAT WOULD *NOT* BREAK DOWN

USKORONA SPLICING COMPOUND
3/4 IN. WIDE
US
30 FT. ROLL
OZONE AND MOISTURE RESISTING COMPOUND
Uskorona combines maximum resistance to OZONE and MOISTURE with high tensile strength, elongation and dielectric resistance. Fuses quickly without heat or pressure and makes PERFECT SPLICES
MADE IN U.S.A.
United States Rubber Company

Uskorona was the only tape of 4 leading brands that was still intact after a 4-hour corona-(ozone) resistance test. All others broke down.

Even after 500 additional hours of consecutive exposure, Uskorona remained as fresh and corona-resistant as at the start.

MORE AMAZING STILL, USKORONA IS THE ONLY TAPE THAT IS RESISTANT TO CORONA *AND MOISTURE.*

No wonder many a leading power company has made Uskorona standard for underground splices, joints and connections. It is thoroughly effective on single or multiple cable, on secondary network systems, street lighting circuits and transformer leads.

For more data on moisture- and corona-resistant Uskorona, write to address below.

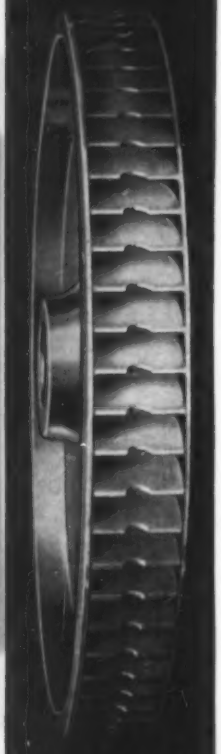
LET US SEND YOU A SAMPLE

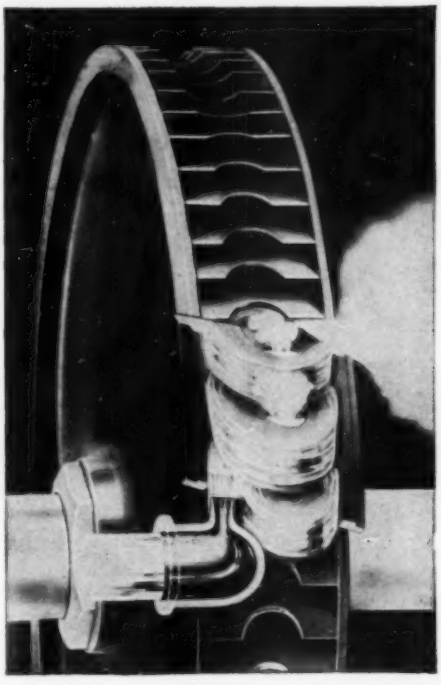
U.S. RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

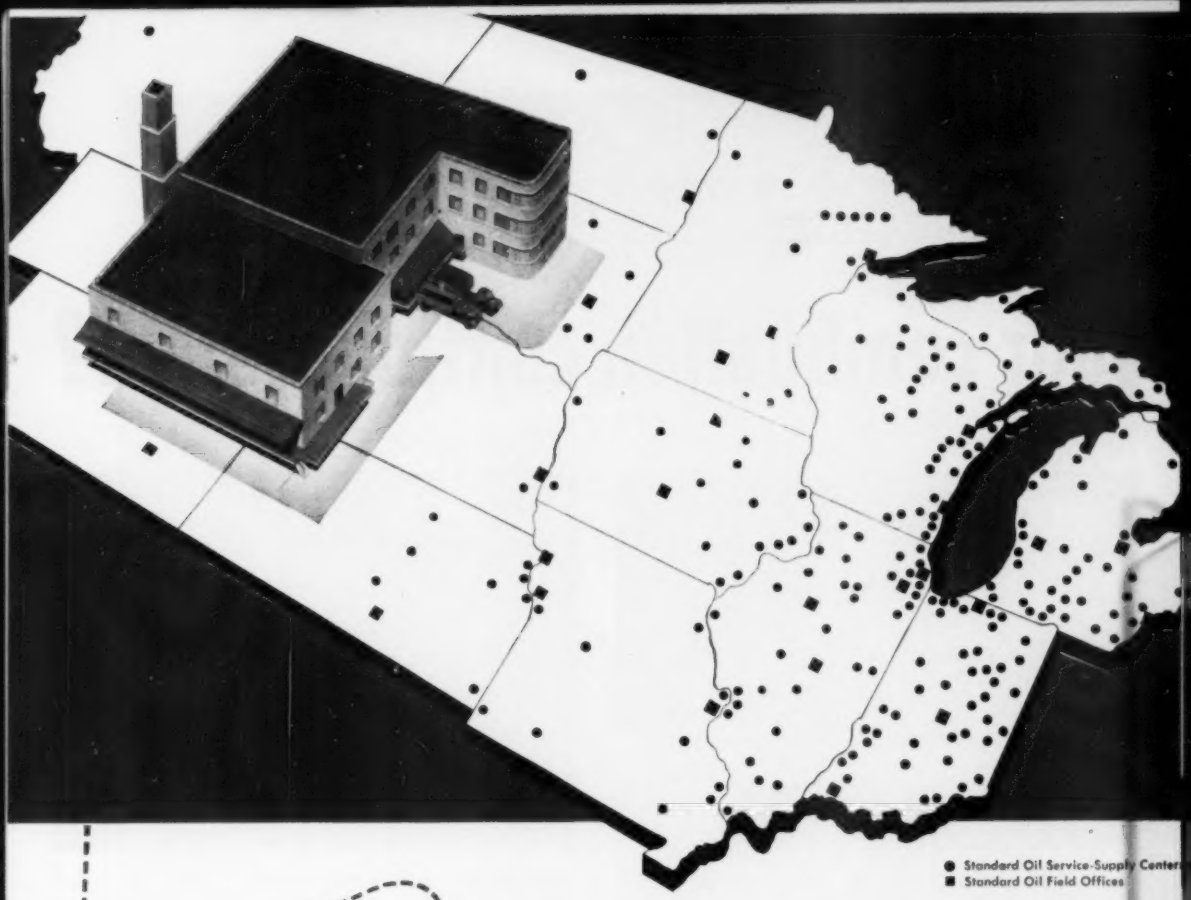
The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



● Standard Oil Service-Supply Center
■ Standard Oil Field Offices

3 IMPORTANT ADVANTAGES

Standard Oil's Lubrication Service is especially geared to serve your midwest operations.

1 **Service-supply points** are near your plant. You are assured of fast deliveries, prompt lubrication engineering service.

2 **Lubrication specialists** have been specifically trained in Standard Oil Lubrication Engineering Schools to help you obtain the maximum benefits from lubricants and fuels.

3 **Research and technical facilities** are geared to help solve your specific lubrication problems.

Right in your own back yard!

● If your plant is in the Midwest, you can benefit from a service-distribution set-up that is unique in the oil industry—there's a Standard Oil office and warehouse practically right in your own back yard. The nearness of that service-supply center holds important advantages for you.

Faster Deliveries. You needn't worry about production delays caused by late shipments of necessary lubricants and fuels. You can avoid the expense and trouble of stocking large quantities of lubricants and fuels within your plant.

A Complete Supply. Every lubricant and fuel necessary to the efficient operation of your plant will be carried in the warehouse at your nearby Standard Oil service-supply center. You can always get the product you need *when* you need it.

On-the-Spot Engineering Service. Your nearby Standard Oil service-supply center is headquarters for a Standard Oil Lubrication Specialist who is assigned to your plant. He is close at hand to give you help when you need it. He has plenty of practical experience. He has been specially trained for his job in a Standard Oil Lubrication Engineering School. He is backed by Standard Oil's extensive research and technical facilities.

To arrange for his visit, phone your nearby Standard Oil service-supply center or write to: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)

STANDARD

what results do you want from

Specific problems call for specific results. Here's proof that industrial plant management gets results as planned, with Hays automatic combustion control systems.

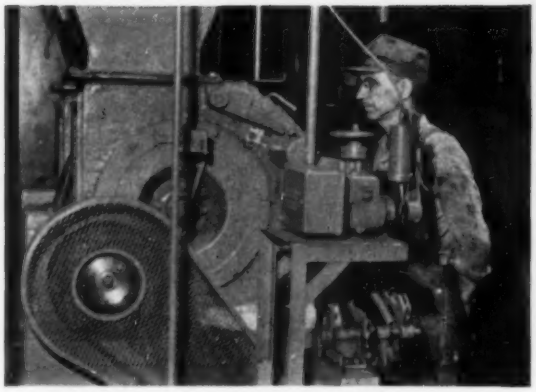
your combustion control system?

Increased efficiency? "Our basic reason for installing the Hays electric automatic combustion control was to obtain better efficiency. Our aim was more than reached . . . efficiency has climbed, attaining 79.3%." *Plant Engineer Manhattan Rubber Div., Raybestos-Manhattan, Inc.*

Low maintenance? "Our aim has always been to eliminate the need for maintenance wherever possible . . . and we are particularly pleased that maintenance has been "nil" with the (Hays) automatic combustion control system." *Chief Engineer, Kurth Malting Company*

Fuel savings? "Our fuel cost per pound of steam has dropped so much since we installed (Hays) instruments and combustion control, that fuel savings alone have been enough to pay for the investment in one year's operation." *Power Plant Chief Engineer, Vollrath Company*

Good CO_2? "The (Hays) controls in combination with our instruments make it possible to maintain high efficiency, as indicated by the 14½% average CO_2 obtained, and keep complete records of our operation." *Chief Engineer, Geo. Ziegler Company*



Rapid response to wide load swings? "We have made test runs using the Hays system, bringing the load rapidly up from 8,000 to 80,000 lbs. per hr. with excellent results. Fuel-air ratio was held at the desired value and CO_2 at 15%." *Chief Engineer of Power Plant, Bemis Bros. Bag Company*

How to get results

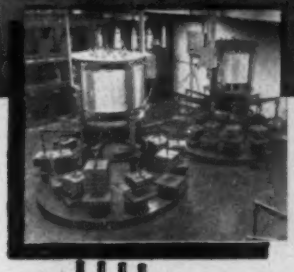
Hays application engineers will provide consultation on the special problems facing your plant. Through careful analysis, working with your actual operating conditions, they will recommend methods to achieve the results you want. Do you face any of these conditions?

Fuel savings—or special fuel problems
Plans to meet increasing load demand
Widely fluctuating loads
Improving efficiency in your plant
Problems in boiler and stoker maintenance
Meeting smoke abatement ordinances
Modernization of obsolete equipment
Accuracy of control in processing
Need for permanent records on combustion performance
Other . . .

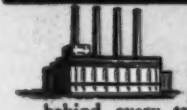
Send for Bulletin No. 49-605 which describes how Hays equipment serves industry. For specific preliminary recommendations, without obligation, send us a brief statement of your combustion problem. Hays Corporation, Michigan City 7, Ind.

The Hays CORPORATION
MICHIGAN CITY INDIANA U S A

AUTOMATIC COMBUSTION CONTROL • BOILER PANELS • FLOWMETERS • VERIFLOW METERS AND VERITROL • GAS ANALYZERS • DRAFT GAGES • COMBUSTION TEST SETS • CO_2 RECORDERS • ELECTRONIC OXYGEN RECORDERS • AIRFILTER GAGES



measuring steam-power progress in millionths of an inch



Indicative of the prodigious exploration and development work behind every technological advance in steam-electric generating practice are these scenes from B&W's new laboratory at Alliance, Ohio. Here, in one of the largest research laboratories of its kind, are conducted tests on the "creep" (plastic flow) and stress-rupture of metals. So precisely uniform are these testing units that temperatures are held to plus or minus one degree F at 1550 F; so accurate that specimen elongations are measured in millionths of an inch.

From such studies in steel come those savings in steam with which B&W Boilers and component equipment have been associated for more than 80 years. For these data on the behavior of metals under a wide variety of pressure-temperature conditions, along with investigations of fuel burning methods, heat recovery, and boiler design, are indispensable pre-requisites to the modern high-temperature, high-pressure boiler.

In the future, as in the past, B&W's great research organization will continue to contribute importantly to any project involving cheaper, more dependable power generation—will spend still more in helping you . . . and the power-consuming American public . . . to *save.*

Helping Industry Cut Steam Costs Since 1867

BABCOCK & WILCOX

D-419

Another Modernization Case History:

has been written . . . this time at

Susquehanna Mills, Inc., Sunbury, Pa.

. . . where the management, in cooperation with its consulting engineers, the Franklin Engineering Corporation, designed, built and put in operation an entirely new and very modern steam plant. This has resulted in substantial savings in labor and fuel costs, improved working conditions, and dependable steam generation to meet rapid load changes.

Two Warren two-stage pumps were selected for Boiler Feed Service. These pumps are single suction; opposed impellers of enclosed design; bronze fitted, and having a 2″ discharge; capacity 160 g.p.m., and 710′ t.d.h. One is driven by a 60 h.p., 3500 r.p.m., 220 volt, 60 cycle motor and the other by a 60 h.p., 3500 r.p.m. steam turbine.

Modernization or Expansion . . . Power Plant or Process . . . it will pay you, too, to check with Warren.

P-23

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC., WARREN MASSACHUSETTS

If all the Cochrane Hot Process Water Softeners installed in the last 25 years were operating all at once at full capacity they would soften well over Fifteen Million Gallons per Hour. That will give you some idea of the dependable service Cochrane Water Conditioning Equipment has been rendering to steam power plants in every branch of industry in the United States and other countries. It is one reason why the name Cochrane carries the authority it does in all fields of industrial water conditioning. Consult Cochrane engineering service on your next water conditioning job.

COCHRANE CORPORATION · 17th St. & Allegheny Ave. · PHILADELPHIA 32, PA.

In Canada: Canadian General Electric Company, Ltd., Toronto • In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City

COCHRANE

HOT PROCESS SOFTENERS · DEAERATING HOT PROCESS SOFTENERS · HOT PROCESS ZEOLITE SOFTENERS

NEW

SERIES 12100*

FORGED STEEL

DROP

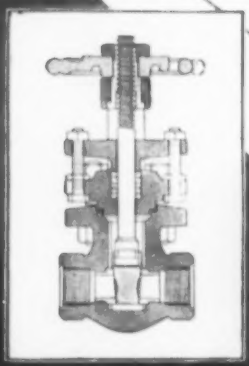
Vogt

BOLTED BONNET
BOLTED GLAND

150-800 POUND

GATE VALVES

SIZES 1/4" to 2"



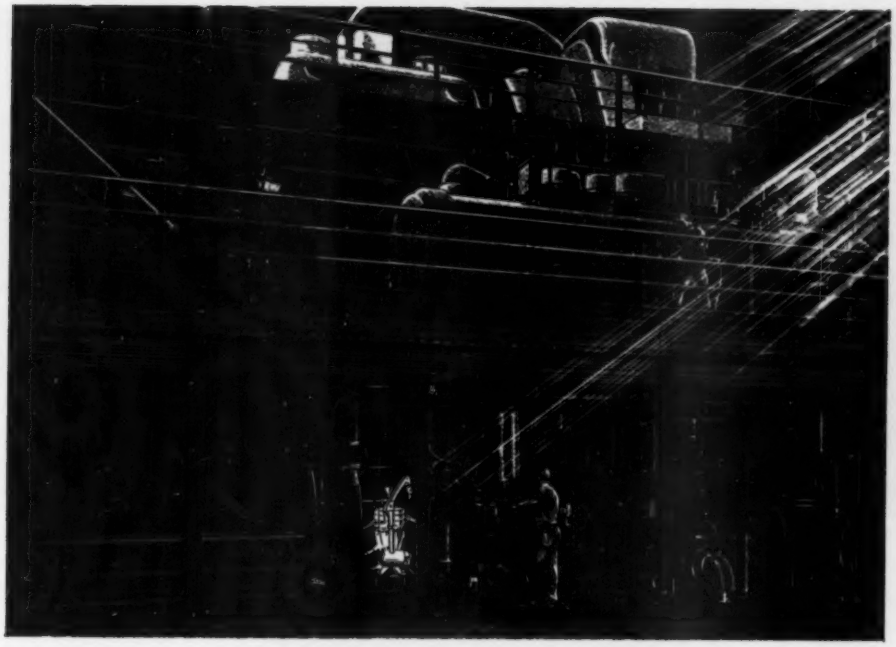
*Series 12100

CARBON STEEL | 800 Pounds @ 750° F.
1500 Pounds Cold Non-Shock

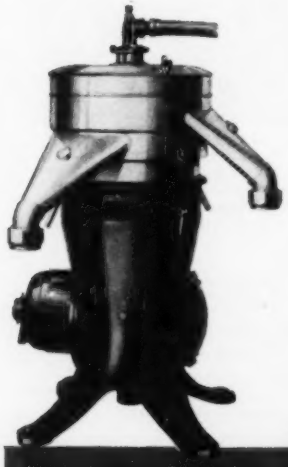
For 150-800 pounds service • Round Bolted Bonnet • Bolted Gland • Gasket or Ground Joint • Outside Screw and Yoke • Renewable Seat Rings • Solid Wedge — Slotted Type • Rising Stem 11½-13% Chrome Stainless Steel Trimmings • Sizes 1/4" to 2" inclusive.

HENRY VOGT MACHINE CO. Louisville 10, Ky.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • ST. LOUIS • DALLAS



THIS "DAVID" PROTECTS "GOLIATH!"



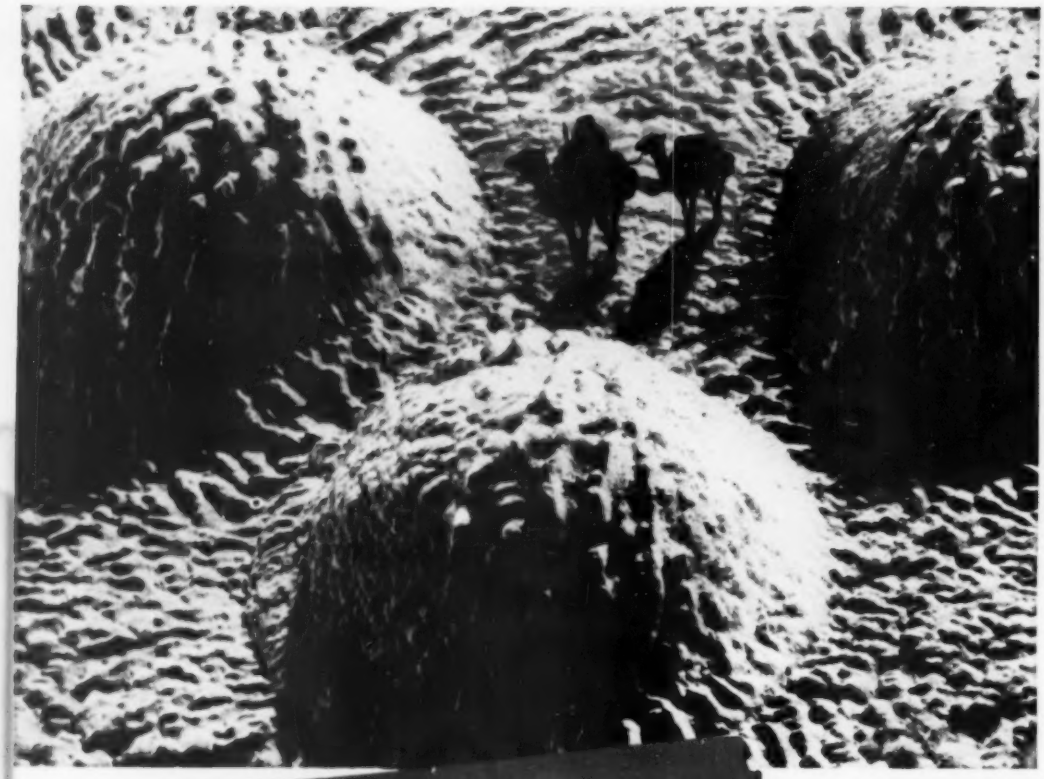
The De Laval Oil Purifier is small in size with respect to the great turbine it guards, but its power to ***protect*** is absolute! Removing dirt and liquid impurities from the turbine lubricating oil as fast as they accumulate, these centrifugal machines constantly keep the lubricating oil clean and dry.

The cost of a centrifugal Oil Purifier is so much less than that of even ***one*** serious shutdown that in effect a centrifugal machine is inexpensive ***insurance*** against trouble. Moreover, there is no expensive upkeep cost with a De Laval, for the purifying action is entirely mechanical.

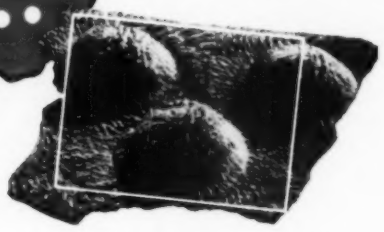
● ***Write for Bulletin TO-1.***

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL
OIL PURIFIERS
FOR MORE DEPENDABLE POWER



Desert Waste...



THIS "desert" was formed under water—improperly treated boiler water. It represents needless waste in several ways . . . Boiler down time . . . Overheated drum and rivet metal . . . Loss of heat transfer efficiency . . . Sluggish response to load changes.

Since the scale was removed, The Nalco System has kept the boiler clean-to-metal and corrosion-free continuously—and economically. Where conditions require uninterrupted boiler operation, The Nalco System can also be utilized to remove old scale, as well as prevent new deposits. Either way, The Nalco System is your assurance of *permanent water treatment results.* Write for prompt action on your problems.

Rectangle in small photo shows area of scale sample in large illustration. "Hills" are scale-covered rivet heads. Approximate size of sample: 7" x 5". *Nalco Laboratory photo.*

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place
Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario

THE *Nalco* SYSTEM . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

INSTRUMENTS AND CONTROLS

101 **Heavy-Duty Insulation Tester**—The higher and wider ranges, longer scales, and improved mechanical features of manufacturer's heavy duty Megger instrument are stressed in Bulletin 21-20, 24 pp. Text describes uses of the instrument and tells why it can be used on large equipment. Design and functions of megger are explained in detail, along with dielectric absorption effect, voltage characteristics. Also discusses multi-voltage testers, motor driven testers and other types, as well as accessories, and includes tips on operating and servicing the testers. Specifications, facsimile scales are included. James G. Biddle Co.

102 **Pneumatic Metering Element**—Company's pneumatic machine used as the metering element in the measurement and control of steam, gas and liquid flow, liquid level, pressure differential and similar applications, is illustrated and described as to application and operating characteristics, in 4-pp Bulletin 2150. Design and operation of the machine are shown in full color drawing. Dimensional, ordering data included. Hagan Corp.

103 **Industrial Control Devices**—Catalog 8303, 64 pp, presents over 100 different models of non-indicating electric, electronic, and pneumatic controllers for flow, pressure, liquid level and humidity applications. A number of important additions to previous line are shown, including electronic temperature controllers. Catalog is indexed and generously illustrated with photos and sketches and includes dimensions, specifications, necessary engineering and ordering data. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

104 **Hydrometers for Industry**—Bulletin G, 16 pp, presents company's line of hydrometers, covering those graduated in conventional scale ranges for routine laboratory testing, special instruments of extreme accuracy for laboratory control work, and standard instruments for general use. Instruments are illustrated by photo and listed with sizes, ranges, intervals of graduation. Standard density and volumetric tables are also included. Precision Thermometer & Instrument Co.

105 **Centralized Control Combinations**—Bulletin CAB-1, 2 pp, introduces company's "cabinet series" of instruments designed for incorporating auxiliary equipment into the case of a direct-reading electronic controller. Describes briefly and illustrates suggestions for combining various control devices; includes specifications, prices. Wheelco Instruments Co.

106 **Hydraulic Controls**—Hydraulic remote controls for industrial use are presented in Bulletin 20-105, 8 pp. Two series of controls and available accessories, including intermediate transmitter for use at secondary control stations, are described and illustrated by photos and sketches. Covers both single tube systems and multi-station remote control systems, as well as company's extra small hydraulic control. Sperry Products, Inc.

107 **Flow Indicators**—Bulletin SC-4.1, 8 pp, describes company's air and gas flow rate indicators of improved design. Illustrated throughout with photos of installations, cutaway and dimensional drawings, the text covers applications of the meters, their construction and operation. Includes selection table and ordering instructions. Selas Corp. of America.

108 **Triple Range Tachometer**—An improved tachometer with three ranges and an overall measuring scope of 50 to 50,000 rpm is illustrated by photo and described in this 4-pp bulletin. Text covers design and construction of instrument, elaborating on important features and accuracy. Includes price, shipping information. Also describes and pictures several of company's other tachometers. Boulin Instrument Corp.

109 **Gas Analyzer**—An improved type of gas analyzer for measuring CO_2, O_2, and CO is described in 4-pp Bulletin 120. Text explains how flue gases from boilers are analyzed to determine effectiveness of combustion, quality of fuels. Illustrations include photos of analyzer and carrying case. Ellison Draft Gage Co., Inc.

110 **Differential Pressure Transformer**—A transformer for measuring differential pressures for indicating, recording and controlling rate of flow of steam, gas or liquid fuel, water and other materials is illustrated and described in Bulletin 2250, 4 pp. Design of transformer is shown in a full-color cutaway illustration and text covers applications, construction features and operating characteristics. Dimensional data included. Hagan Corp.

111 **Annunciator**—Of special interest to power engineers is this 4-pp bulletin illustrating and describing the function and construction of company's annunciators for use in control panels, control desks, in public utilities and industries. Actual size illustrations of the unit's plastic windows are presented. Also included is a schedule showing dimensions of the annunciator with from one to 400 windows, as well as illustrations of typical conditions and occurrences which may be indicated. The Autocall Co.

112 **Alarm Service Annunciator**—A unit type audible and visual annunciator designed for alarm services in public utilities and industries is illustrated by photo and described as to construction and operation in this 2-pp bulletin. Stresses economy and adaptability of the annunciator and gives mounting and installation suggestions. The Superior Appliance Co.

113 **Care of A-C Rotating Equipment**—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and include such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and proper machine applications. Machine repair chapters include data on stator coil and slip ring rotor repairs, balancing of rotating equipment. Allis-Chalmers Mfg. Co.

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ELECTRICAL

114 Time to Retire Your Watthour Meters?—To aid power engineers in determining the economic point at which to retire older watthour meters, Bulletin GEA-5440, 12 pp offers direct suggestions and includes an evaluator for making the job easy. The evaluator—a plastic circular slide-chart with scales showing cost of new meters, age of old meters etc.,—is based on an economic formula developed by company engineers and explained in the bulletin. Use of this formula and the evaluator will assist in setting up planned retirement programs. Comparison of cost of retiring and keeping in service old meters, as determined by the evaluator, answers the question, "When is it economy-wise to retire a group of meters?" Booklet also describes and illustrates company's new meters, showing their improvements and advantages. General Electric Co.

115 Magnetic Starters—Bulletin 4120, 4 pp, illustrates and discusses a-c magnetic starters of the combination across-the-line type with fusible and non-fusible disconnect switches. Text covers their special features, application, construction, overload relays, auxiliary contacts, types of control, operating coils and enclosures. Dimensional data included. Ward Leonard Electric Co.

116 Control Cables—Bulletin 5013, 4 pp, describes a small diameter 600-v control cable that is tough, flexible and lightweight. Illustrates its construction, showing use of polyethylene, nylon and company's Rockhide with the stranded tinned copper conductor, and includes photos of some typical applications for this cable. Sizes, specifications, advantages are listed. Rockbestos Products Corp.

117 Independent Generating Sets—Illustrated Form BEI, 4 pp, describes many uses for independent electric generating sets and the variety of types and sizes company has available. Folder is intended to help engineers considering an electric generating set for a specific application and in determining best type of set to suit needs. Universal Motor Co.

PUMPS

118 General Service Pumps—Bulletin 30, covering company's helical gear pump, explains its "progressing cavity" principle of operation and lists some of the wide variety of materials this pump is designed to handle. Dimensions, speeds, capacity information and other data is included for both the standard type and the tubular type for higher pressures and greater resistance to abrasion. Illustrated with cutaway drawings, photos of pump and installations. Pump Div., Robbins & Myers, Inc.

119 Pump Cups—Form 4502, 8 pp, is on company's improved material for packing pistons of air and hydraulic cylinders and reciprocating pumps. Explains how these "Pumcups" are designed to lengthen service periods and packing life and reduce cylinder wear. Describes and illustrates types of hydraulic machines in which they are used. Includes sizes and engineering data on the cups and discusses special pistons manufactured for them. Bulletin also cites several case histories of installations. Darling Valve & Mfg. Co.

120 Process Pumps—Bulletin 1123, 4 pp, describes manufacturer's new line of process pumps designed for handling hot or cold clear liquids, viscous liquids, corrosive liquids or liquids carrying suspended solids, in capacities from 15 to 600 gpm. Bulletin includes cross-section illustrations showing both open and closed impeller designs and photos of special construction features. Also provides capacity and head range diagrams for 1750 to 3500 rpm speeds and dimension table. De Laval Steam Turbine Co.

121 Centrifugal Pumps—Four-pp Bulletin W-318-B21 on two-stage double suction centrifugal pumps for pipe lines, boiler feed, general water service and other applications, illustrates their design and construction and discusses their important features. Includes dimensional data and selection chart. Worthington Pump and Machinery Corp.

VALVES AND FITTINGS

122 Regulator Valves—Bulletin S-22-C, 12 pp, covers company's complete line of valves for controlling gases and liquids in level, temperature or pressure requirements. It is illustrated with photos, diagrams and drawings and gives full specifications and selection data on regulating valves, valve accessories and pressure master controls. The Swartwout Co.

123 Handbook on Fittings and Flanges—Catalog wf-1936, 96 pp, is packed with working information on manufacturer's seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, this book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings stocked in other metals such as stainless steels, Inconel, pure nickel or Monel, aluminum, deoxidized red brass. Grinnell Co., Inc.

124 Pipe Fittings—Here's an illustrated data sheet covering threadless union pipe fittings, tees and couplings for connecting black or galvanized pipe without threading of pipe ends. Tells how fittings are used and how to install them. Includes sizes, prices. Union Products Co.

STEAM ACCESSORIES

125 Steam Plant Equipment—Blow-off valves for low, medium and high pressure service, water columns and gages, liquid level indicators, expansion joints, traps, strainers and other steam plant equipment for utilities, industries and institutions are described and pictured in 12-pp Bulletin G-1307. Illustrations include photos, sketches showing design details and construction. Sizes and other ordering information included. Yarnall-Waring Co.

126 Steam, Air, Gasoline Traps—This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lbs; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 600 lb, and also steam, air and gas separators. Includes capacity tables, installation diagrams as well as a discussion of typical applications, and a section giving data, charts and formulas for determining proper size trap for specific applications. W. H. Nicholson & Co.

127 Air Eliminator—Illustrated Bulletin 119 is a specification sheet covering company's high pressure eliminator for automatic closing against steam under pressures up to 150 lb. Lists equipment for which eliminator is recommended, gives price. Gorton Heating Corp.

HEAT EXCHANGERS

128 Heat Exchangers—Improved heat exchangers of a type originally used for naval combat vessels and redesigned for high thermal efficiency and general industrial use are described in 8-pp Bulletin 2.2K1. Large cutaway illustration shows packed floating head, removable tube bundle and other design features. Increased heat transfer surface is also

(Continued on page 108)

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SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS

800 FEET OF BURIED WATER LINE CLEANED IN 8 HOURS BY DOWELL CHEMICAL SCALE REMOVAL SERVICE

Dowell Service may save you important dollars by cutting out-of-service time in maintenance cleaning to a minimum. Special chemical solvents, introduced into water lines through regular valve openings, are designed to dissolve and disentegrate scale and sludge deposits *without dismantling* the line! For example, Dowell engineers were recently called in to clean 800 feet of 4" buried water line heavily scaled with three quarters to one inch of calcium carbonate. *Within eight hours, the water line was back in use with its volume increased from 45 g.p.m. at 32 lbs. to 125 g.p.m. at 24 lbs.!*

Underground or above, indoors or out, if you have a water or product line cleaning problem, call Dowell. Leading utilities, railroads and other industries have found the Dowell Service method practical, reliable and economical. Thoroughly trained Dowell engineers do the entire job, bringing all necessary chemicals and equipment to your plant in special tank trucks.

Call your nearest Dowell office today and find out about rapid, convenient, economical Dowell Chemical Scale Removal Service for heat exchange equipment, boilers, condensers, water-lines—and for increasing water well output. Free cost estimates are gladly given.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

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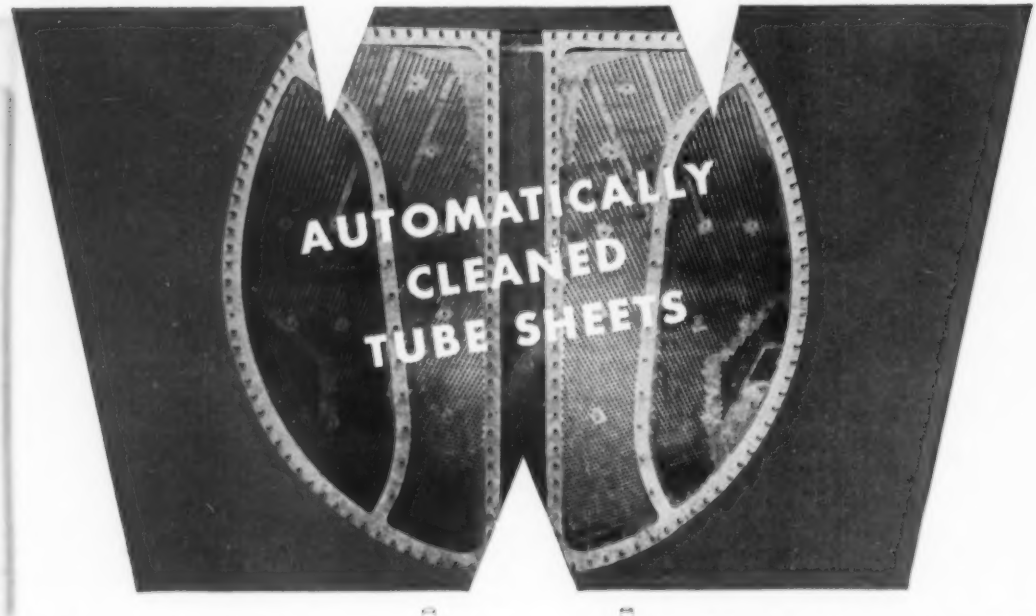
DOWELL

A SERVICE ORGANIZATION

An actual user benefit provided by

Wheeler's skill in engineering

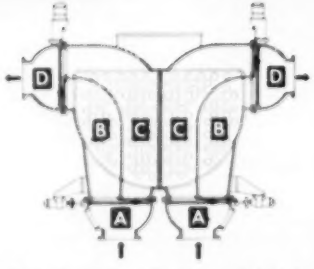
REVERSE-FLOW CONDENSERS



Loss in operating time and the cost of periodic cleaning has been eliminated by using C. H. Wheeler's reverse-flow condenser. The reverse-flow condenser automatically cleans its own tubes and tube sheets periodically with no pause in operating efficiency. And the reversal of water flow is done almost instantly, merely at the touch of a button.

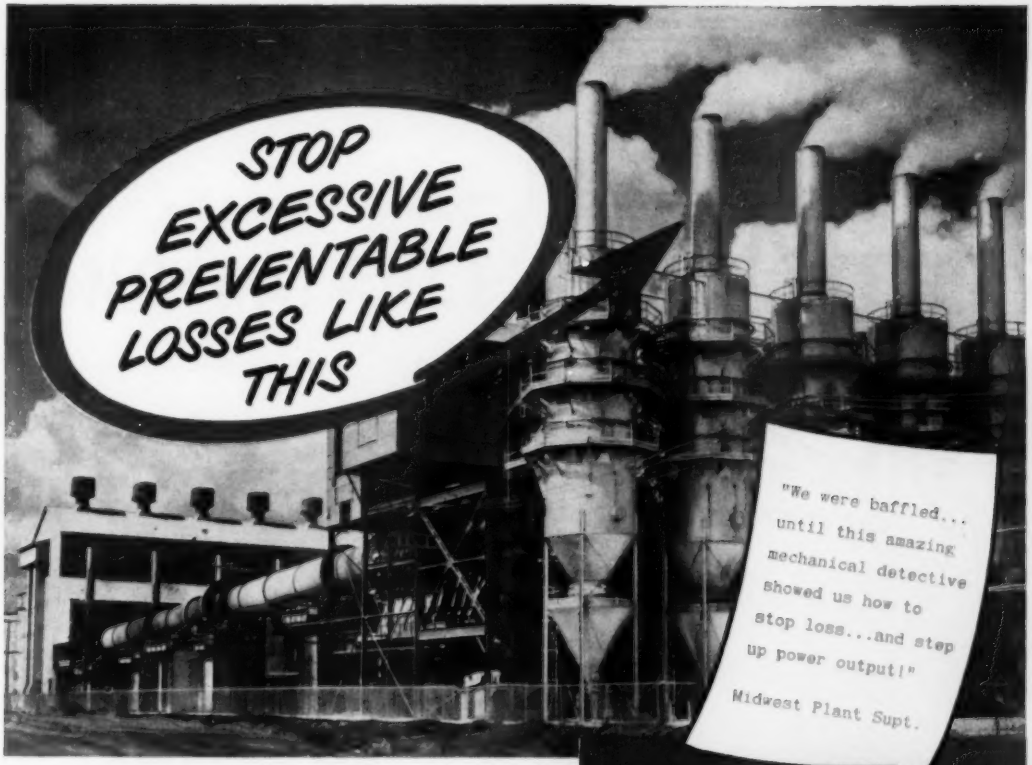
While your installation may not require a reverse-flow condenser, it is just one example of Wheeler's skill in engineering. With over fifty years experience in the power field—and, with usually more than a quarter-million square feet of condensers on the production lines—it is inevitable that Wheeler leads in condenser design.

When you have any heat transfer or vacuum problem, you can count on the right answer from skilled, experienced engineers . . . from C. H. Wheeler Mfg. Co., 1802 Sedgley Ave., Philadelphia 32, Pa.



In the operation of a C. H. W. "Reverse-Flow" Condenser, with divided water box, water enters valve chamber at A with left hand valve port open to permit water to flow through pass B, then changing direction at other end of condenser and flowing back through pass C and out through the upper port of D. To reverse flow, valves at inlet A and discharge D are changed to permit water to flow through C first, returning through B and out through the lower port of D. Both halves of the condenser are operated in similar manner, but independently of each other.

C.H. Wheeler OF PHILADELPHIA [STEAM CONDENSERS • WATER COOLING TOWERS
EJECTORS • STEAM JET VACUUM REFRIGERATION


STOP EXCESSIVE PREVENTABLE LOSSES LIKE THIS
"We were baffled... until this amazing mechanical detective showed us how to stop loss...and step up power output!"
Midwest Plant Supt.

"For entirely too long our low power output had been a bothersome problem, till the lucky day the Cities Service engineer called to demonstrate the Industrial Heat Prover.

"We gladly accepted his offer to make a free analysis, and the results were miraculous! In almost no time he found the cause of our trouble—cracks in the brick work that caused large quantities of heat to be wasted. We made the necessary repairs, and increased our average power output by 22%!

"This Cities Service man is now one of our good friends. Might pay you to meet him too."

The Industrial Heat Prover is a flue gas analyzer. It tells you quickly and accurately how much efficiency you are getting from furnaces and heat production units.

FREE—For a complete description of the Cities Service Heat Prover mail coupon below for this free booklet.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

CITIES SERVICE OIL COMPANY
Sixty Wall Tower, Room 618
New York 5, New York

Please send me without obligation your new booklet entitled "Combustion Control for Industry."

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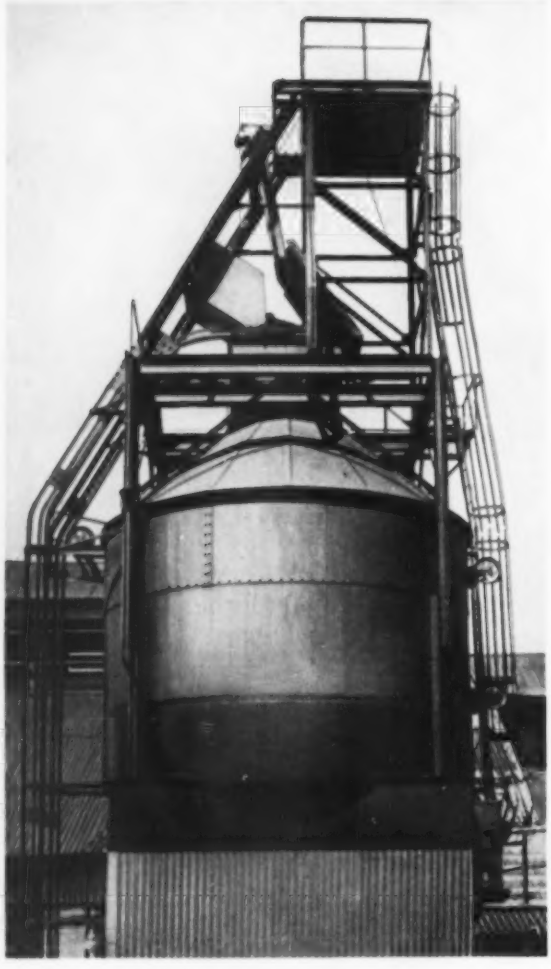

LOW COST DEPENDABLE COAL HANDLING FOR PUBLIC UTILITIES

Salem Gas and Light Company, Salem, Mass., found a G-W Skip Hoist the ideal solution to the problem of conveying coal and coke to producer storage. The skip bucket keeps the producer-storage bin filled at all times . . . and does the job with maximum economy.

Gifford-Wood Skip Hoists . . . one of many G-W systems of materials handling . . . are low in initial cost . . . low in maintenance . . . long-lived . . . completely dependable. Public utility companies the country over are becoming increasingly interested in Skip Hoist handling of coke, coal and ashes where space is limited and both initial and operating costs must be kept at rock bottom.

This particular installation may not be the perfect solution to your own particular problem. Gifford-Wood, however, has specialized in the design, engineering and installation of all types of materials handling systems for 136 years. To have a Gifford-Wood Materials Handling Engineer survey your present method of moving materials, places you under no obligation and it may well be your first step toward lower operating costs and increased production.

GIFFORD-WOOD CO.

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When You Think of Materials Handling — Think of Gifford-Wood

Initial adjustment by experienced combustion engineers assures proper weighting of all factors

when you install HAGAN

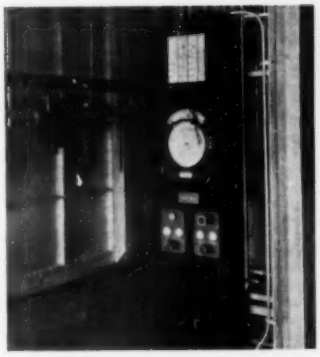
RING BALANCE BOILER METERS

The relationship between the steam flow and air flow records on your boiler meter should be a reliable check on the operation of your automatic combustion control system and a dependable guide for manual control.

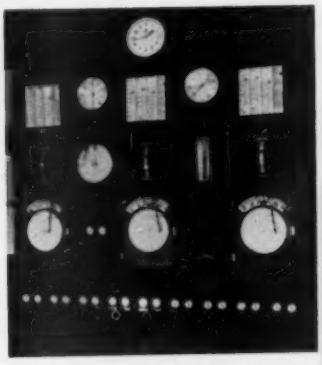
To be sure of a true record of this relationship, you need a sensitive, flexible meter *accurately adjusted so that you may take into account every factor of operation which is affected by excess air.*

That is what you get with the Hagan Ring Balance Boiler Meter. The design and construction of the meter make it inherently sensitive and accurate over a very wide range. Experienced Hagan combustion engineers — men thoroughly familiar with boilers and control systems as well as meters — make the precise initial adjustments essential for continued satisfactory service.

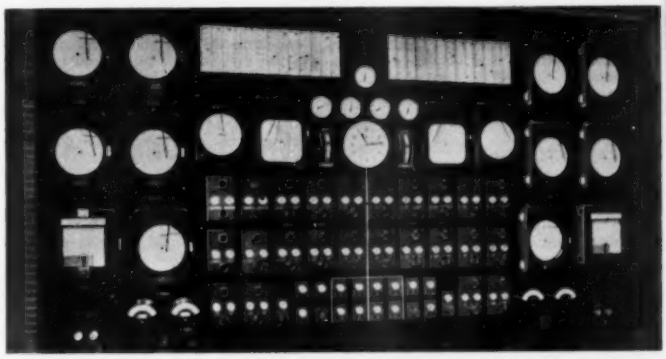
For full information about these and other Hagan Ring Balance Flow Meters, fill out the coupon below or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.



Hagan Boiler Meter of the recording, and indicating type at Crown Paper Board Co. A third pen records stack temperature. Integrator continuously totalizes steam flow.



Indicating, recording and integrating Hagan Ring Balance Boiler Meters at Artloom Carpet Company. These meters also record stack temperature.



At Alan Wood Steel Company, Hagan Ring Balance Meters are used to measure and record flow of blast furnace gas, coke oven gas and steam, also boiler water level. These meters are recording only.

HAGAN HALL BURDMIN CALGON

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Ring Balance Meter Division
Hagan Building, Pittsburgh 30, Pa.

Please send me Hagan Bulletin 2M50.

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Position _____

Company _____

Street and Number _____

City _____ Zone _____ State _____

G3

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 37-38.

1—AUTOMATIC TIMER

To control timing operation of screens and pumps in power plants

This device, intended to reduce footwork and human error, controls timing operations by means of an automatic rotor timer and an integrated system of wire terminals and controls enclosed in a single cabinet. One person at a single point can thus control operations of machinery at several points in one or several buildings, company explains.

Any number of pumps and screens can be operated for any desired periods of time, it is said, and timing rotors are interchangeable. Manual operation can be substituted by a quick switch-over. Three-way heavy-duty switches, silicone prelubricated motor, automatic pressure controls, and alternate wiring for several circuits to assure operation if one circuit fails, are among features stressed for this timing device. Midwest Automatic Control Co.

2—HAND TORCH

Uses self-pressurizing fuel and disposable steel fuel container

Prepo Hand Torches are designed to light instantly with a match. Their seamless fuel containers, the size of a beer can, are intended to be quickly sealed into position as the fuel tank. Empty containers, readily replaced by full ones, are thrown away.

The fuel used is a self-vaporizing liquid petroleum fuel, self-pressurizing at normal temperatures. The torch has two interchangeable burner tips. The larger one throws a long, broad flame for work where a great deal of heat is required quickly. The other tip has a long pinpoint flame for soldering and other work where heat must be concentrated in a small area.

The torch weighs only 1½ lb and its small size makes it a "tool box tool." According to manufacturer it can be used with above average safety for applications where heat or flame is needed quickly because the fuel is nontoxic and non-poisonous and is packaged in a container able to stand many times the pressure of the fuel. Pressure Products Corp.

3—PORTABLE INDICATOR

For covering wide range of voltage, frequency in checking phase sequence

The K-3 Knopp Indicator is for use on 60 to 600-v circuits as compared to maximum of 500 v in company's previous model. It can be used for checking phase sequence of circuits having a frequency above 60 cycles by raising the minimum circuit voltage above 60 v, the maximum frequency being 400 cycles, company points out, giving as an example its use in checking 180-cycle circuits of 200 v or more.

This portable indicator is recommended for use with wiring, installing and testing of polyphase circuits and apparatus. It is said to save time, protect equipment and eliminate "phasing in." To determine phase sequence, whether A-B-C or C-B-A, it is only necessary to clip on leads, push button, and set direction of disc rotation. Correct indication is claimed, regardless of voltage or circuit conditions without changing taps or dials. Electrical Facilities Inc.

4—ALKALINITY INDICATOR

Is intended to give quick, accurate analysis of total alkalinity

The end point of this total alkalinity indicator occurs at exactly the same pH as methyl orange, company explains, and it is used in exactly the same way. However, it is reported to give a clearer and more distinct end point, necessary in the case of colored and turbid solutions. Indicator is green when in alkaline solutions. Just before end point is reached the greenish color changes to grey and, at the end point, the grey changes to purple. Power Chemicals Div., E. F. Drew & Co., Inc.

5—CONE-TYPE PACKING

For use in stuffing boxes where free spindle operation is required

Chemiseal 810C is formed of Teflon, described as chemically inert and noncontaminating to any material. The natural slipperiness of Teflon is said to make it ideal for packing because it does not freeze valves even though unoperated for long periods. Teflon is intended to withstand temperatures from -150 to 550 F.

Chemiseal 810C is supplied as a series of cone-shaped rings, and it is explained that in this design the sealing action is derived partly from the flexing of the cones and not entirely on deformation. It is noted that since less pressure is needed to cause the flexing, even low gland pressure exerts a flattening action, forcing the cone-shaped segments outward against stuffing box and inward against spindle with sufficient pressure to maintain a seal yet create minimum friction and allow free spindle operation.

Chemiseal is available with adaptors for square-end or chamfered-end stuffing boxes. If necessary, cones may be split. United States Gasket Co.

6—HUMIDITY INDICATOR

Is pocket size, shows humidity by wet-and-dry bulb method

The TAG Pocket Humidicator Model 8704 is shorter than a pencil and can be used in the hand or mounted on a wall. A built-in slide rule converts wet-bulb and dry-bulb readings directly into relative humidity. The device consists of two etched scale glass thermometers, individually calibrated and secured in a white plastic case by integral resilient mountings. The psychometric slide rule forms the cover

of this case. For use, a few drops of water are applied to the thermometer wick and the instrument is fanned or swung for several moments. Setting the wet-bulb reading opposite the dry-bulb reading on the slide indicates relative humidity. Weston Electrical Instrument Corp.

7—LIQUID-FORM INHIBITOR

For increasing life of transformer insulating oils by deterring sludge

Impruvol 20 is a di-tert-butyl-paracresol inhibitor, a type long used in turbine oils. Its use in transformer oils was delayed partly because the product was a solid and partly because of a lack of experimental data, company states, adding that these difficulties were overcome by preparing the inhibitor in a liquid form and carrying on necessary laboratory and field work. Tests are reported to show that savings are made possible by its use not only with new oil, but also with oils reclaimed by clay treatments. Chemical Div., Koppers Co., Inc.

8—CONTROL CABLE

Is small diameter, lightweight type for 600 v operation at 168 F

PNR Cable is said to offer high dielectric strength, low dielectric constant, low power factor and low water absorption as well as high chemical resistance. It is constructed of stranded tinned copper extruded with a polyethylene primary insulation, a nylon jacket, and a tough outer sheath of company's Rockhide. This sheath is intended to provide extra protection against weathering and direct sunlight, as well as against oil, grease, gasoline

Profitable way to purchase piping ... Get everything from CRANE

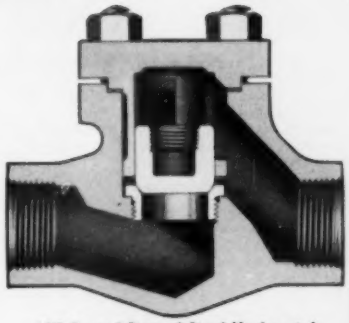
SMALL STEEL LIFT CHECKS WITH BETTER FLOW

Looking for small steel lift checks that don't chatter, and have extremely low pressure drop? Then specify these Crane 600-Pound Forged Steel Lift Checks. They have a patented cap-sleeve construction that provides high disc lift, even at low velocities, thereby eliminating destructive pounding and chattering. Special design of body contours and port openings give unusually low pressure drop.

Seats and discs are of wear-resisting Crane Exelloy. Rugged, forged steel bodies will withstand severe, high pressure services.

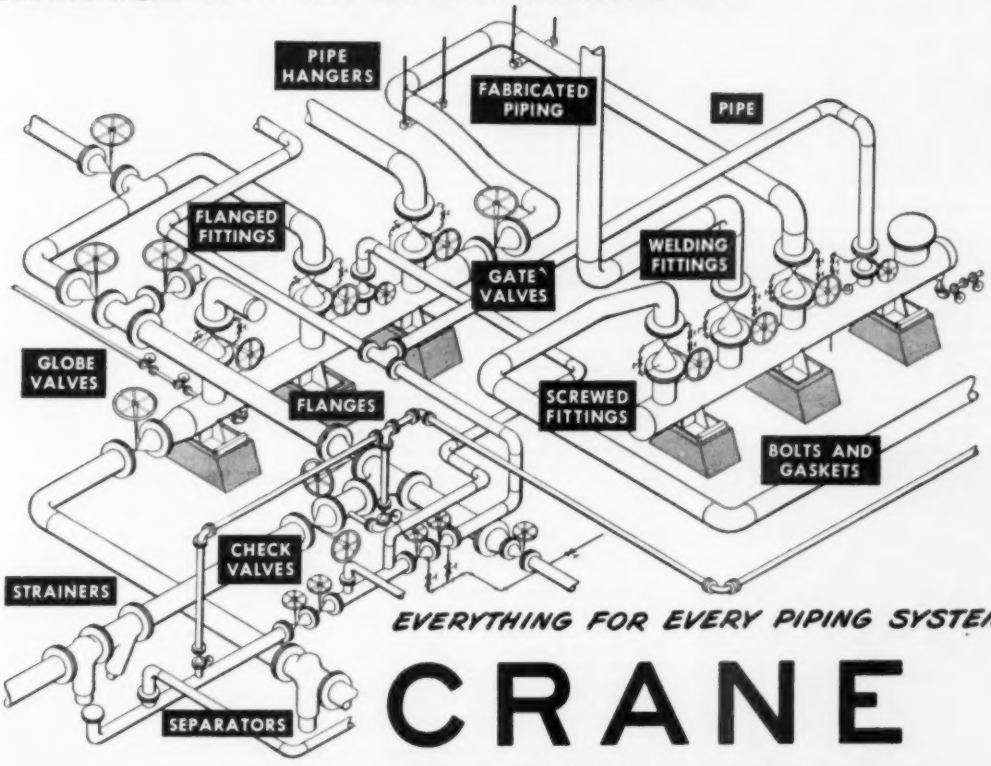
You can get these checks with union caps, screwed or socket welding ends, sizes ¼ through ¾ inches. Or with bolted cap, screwed, socket welding, or flanged ends, in sizes ½ through 2 inches. See your No. 49 Crane Catalog, pages 248-249.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



600-Pound Forged Steel Horizontal Check with Bolted Cap. For steam, water, air, and gas up to 850° F.; for oil or oil vapor up to 1000° F. Sizes: ½ to 2-in. Screwed, flanged, or welding ends.

THIS HIGH PRESSURE STEAM SYSTEM CAN BE 100% CRANE-EQUIPPED ... THROUGH ONE PURCHASE ORDER



EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

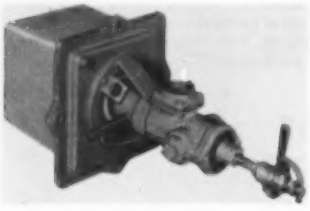
or alcohol, and to permit installation where chemical fumes are present.

This smaller cable is also said to offer good low temperature flux and non-restricted application in conduit, direct burial or exposed overhead. Rockbestos Products Corp.

9—DUAL FUEL BURNERS

For firing with light or heavy oils and low pressure air or gas

The Series 225 Dual Fuel Burners are combination gas-oil burners especially designed for rugged applications. They are now available in 1-1¼ in., 2 in. and 3 in. sizes. A major feature is the refractory tile used, said to give greater stability to the flame without causing



carbon formations. The tile is shipped from the factory cemented and bolted to tile mounting plate, rather than separately. This is to simplify installation of tile to furnace and to prevent tile from separating from its mounting during operation and causing air to leak in around the setting. The North American Mfg. Co.

10—VOLT-AMMETER

Is small sized unit for general maintenance and repair work.

The Amprobe Model A-5-1 has seven ranges: 6.5/13/26/65/130 amp and 150/600 v. Like company's other two small-sized volt-ammeters, this one is 7⅛ in. long by 2⅝ in. wide by 1⅛ in. thick, and the split-core transformer handles conductors up to 1⅛ in. dia. The transformer core is insulated with a molded plastic cover designed to withstand 5000 v a-c.

Case and scale window are also molded plastic. According to manufacturer the meter has an accuracy of ± 3 per cent of full scale. It is packaged in a top grain cowhide case with zipper closure. Pyramid Instrument Co.

11—FLUID COOLERS

For air-cooling engine jacket water and lubricating oil in power plants

This line of 22 standard production dry-type fluid coolers offers capacities from 66,250 to 7,630,000 Btu per hour. The smallest, with an 18 in. 1 hp fan, will handle 2200 cu ft of air and a flow of 20 gpm. The largest unit, with a 144.1, 34 hp fan, handles 220,000 cu ft and 1000 gpm.

Each cooler consists of a cooling core, or extended surface heat transfer coil, containing the liquids to be cooled; a balanced propeller fan to blow cooling air across the coils, and a heavy duty casing. Through simple combinations of coil circuits, one standard unit can dissipate heat from two or three different fluids, at different entering and leaving temperatures and different quantities of liquids. For example, one cooler can cool both jacket water and lube oil as well as help to dissipate exhaust fumes.

While intended primarily for diesel, gasoline and gas power plants, these dry type fluid coolers have special applications in chemical and petroleum processing, gas and electrical transmission. The Trane Co.

12—RECORDING TURBIDIMETER

For monitoring, controlling processes where turbidity is of significance

Here is a photoelectric instrument designed to automatically measure and record the amount of suspended particles in a liquid. It gives continuous readings of turbidity, alerting operator when predetermined limits are exceeded. Company says the new device is expected to fulfill requirements of daily raw water and finished water turbidity reports required by many state health departments.

The turbidimeter operates on the principle that turbidity of a liquid varies in direct proportion to ratio of scattered light to transmitted light through the liquid. It is pointed out that results are not subject to variations in voltage supplied to light source used or color variations of liquids tested.

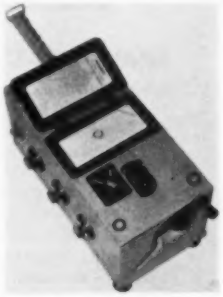
Equipment consists of a bronze sampling chamber, mounted at the process, and either a strip or circular chart recorder which may be remotely located. The light source is a 100-w projection lamp. Recording element may be furnished calibrated on the silica scale or uncalibrated for calibration to agree with previous records. Operating on a 115-v, 50/60-cycle circuit, the equipment has a power consumption of approximately 150 w. Special Products Div., General Electric Co.

13—INSULATION TESTER

Has higher, wider range—up to 50,000 megohms, 2500 v d-c

The extended ranges available in these Megger Insulation Testers are said to be particularly useful in testing circuit breaker bushings and in making time-resistance (dielectric absorption) tests on apparatus which has relatively high 10-min insulation resistance valves.

The wider ranges are accomplished by two overlapping scales resulting in an 8½ in. scale length. A simple switch selects between one scale or the other without use of a multiplier or divider. This Megger is intended to function as a simple, relatively inexpensive tool for detecting deterioration in bushings. In



the cases of some generators, transformers and cables with relatively high 1 min. insulation resistance values, which may increase with time during time-resistance tests, the instrument range should be high enough to permit this increase with time for accurate observation, company states. James G. Biddle Co.

14—BRAKE-MOTOR

Is for use on cranes, hoists and conveyors, has enclosed brake

These are company's Tri-Clad motors equipped with Stearns magnetic brakes as unit apparatus, it is explained, and all types of the motors up to 20 hp, 90 ft-lb static torque are available with the explosion-proof, electrically operated brake. For flexibility, brake combinations are selected to operate at 100 and 150 per cent of full-load motor torque. An adjustment nut sets torque for specific load conditions, enabling operation below maximum rated torque whenever possible.

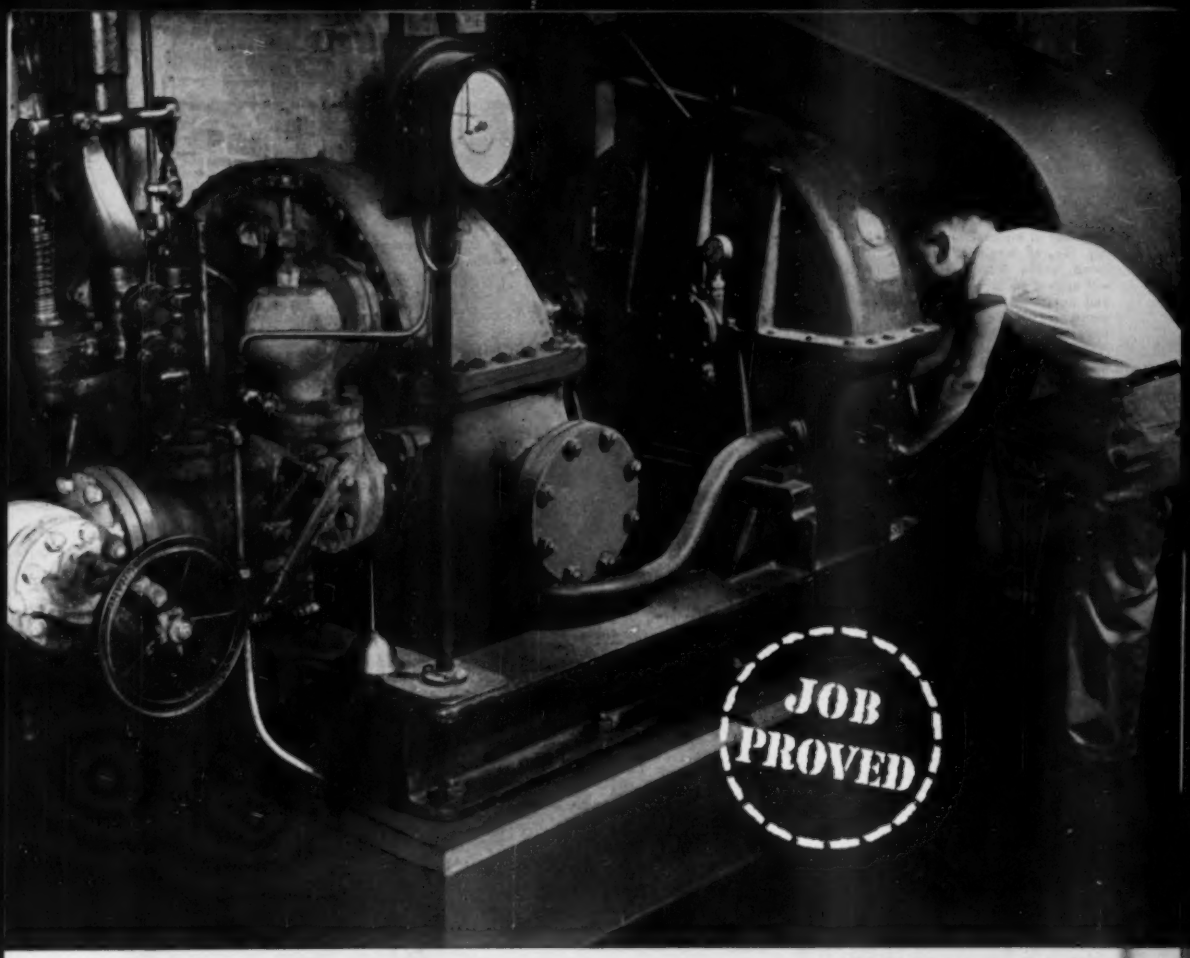
Brake linings are of high-friction material, company states, and in normal operation the only maintenance required is the screw-driver adjustment which compensates for wear. A wear indicator, viewed through a plastic window, tells when this is necessary. Manual release is accomplished by removing the plastic window. All brakes are totallly enclosed and brake cover is sealed to housing. The brake will continue to hold even if power fails during operation, it is said, because of the spring-set, solenoid-release design. Small and Medium Motors Divs., General Electric Co.

15—SWITCHES, TIMER RELAYS

Metal clad, mercury type, are improved for longer service life

The use of triple distilled mercury, a higher-arc ceramic and a metal-conditioning process to reduce resistance are credited with adding considerably to the life of company's metal-clad mercury switches and timer relays. The highly refined mercury is said to result in a noticeably lower ohms resistance and to make it possible for switches and relays to operate at greater capacity, or at former capacity for longer periods of time.

The "higher-arc" ceramic is said to add to the arcing life and the metal-conditioning process to afford reduced resistance. Durakool, Inc.



SUNVIS 900 OILS REDUCE COSTS 25%

Papermaker Gets Maximum Equipment Protection, Extra Long Service, from Superior Turbine Lubricants

In a large paper mill, eight steam turbines drive paper machines and pumps, and generate power for ventilating equipment. Ten years ago the mill began lubricating these turbines with a "Job Proved" Sun oil. They gave unfailing service with remarkably low oil and maintenance costs.

Four years ago, when Sunvis "900" Oils first became available, the Sun representative serving the mill saw an opportunity to effect even greater economy. He suggested that the medium-priced Sun oils in use be replaced by the more costly Sunvis "900" Oils. He knew that these modern, fortified lubricants—*more costly* on a per-gallon basis—would prove *less costly* through the years because of their remarkably long life. His suggestion was followed.

The Sunvis "900" Oils have fully justified this confidence, saving the mill 25% or more on lubrication costs. Furthermore, the papermaker knows his equipment—running or idle—is fully protected from rust and corrosion.

Sunvis "900" Oils are *good for the life of your production equipment.* Coupled with the know-how of the Sun representative who calls on you, they are good for your pocketbook, too. For more information, send for a copy of the illustrated booklet "Sunvis '900' Oils". Write Department PN-6.

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This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 **Dowtherm Vaporizer**—Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. It is illustrated with photos of the vaporizer and includes a dimensional drawing, vaporizer chart and specifications. Also included is table showing general properties of Dowtherm "A." The Wickes Boiler Co.

203 **Rotary Tube Cleaners**—Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors and hose for use with cleaners. Roto Div., Elliott Co.

204 **Tube Expanders**—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators and like equipment. Various models are illustrated by photo and described as to application. Also included are engineering drawings to show typical applications of one model. Accessories for tube expanders are also described and illustrated. Thomas C. Wilson, Inc.

VALVES, TRAPS, PIPING

205 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

206 **Cooling Controls**—Fully illustrated by photos and engineering drawings, Bulletin 700 describes several types of automatic cooling controls. These include a water blender for recirculating control of jacket water temperature of internal combustion engines and compressors, a brine recirculation control, a blender for recirculation control on small engines, a cooling control for engine and compressor jackets, condensers and degreasers, as well as temperature regulators for refrigeration, air conditioning, and cooling, and also pipe strainers. Includes dimensional and capacity data and prices. Sarco Co., Inc.

207 **Pipe Hanger Catalog**—Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

208 **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 **Rubber Expansion Joints**—This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

211 **Flanges for Severe Service**—This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

212 **Steam Traps**—Catalog 448, 32 pp, provide dimensional, application and engineering data on company's line of steam traps. Includes prices and weights and ordering information and generously illustrated. Covers industrial steam traps, expansion steam traps, weight-operated and piston-operated types, continuous flow gasoline trap, separators and related equipment. W. H. Nicholson & Co.

213 **General Service Valves**—Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe lines. Included are tables of dimensions, weights and list prices for straight lever and rack-and-pinion types, inside packed and with outside stuffing box and with screwed or flanged ends. Everlasting Valve Co.

214 **Unions and Fittings**—Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. Also illustrates all equipment offered, along with sizes and materials available. Catalog is accompanied by current price list. E. M. Dart Mfg. Co.

215 **Strainers**—Bulletin S-202, 4-pp, describes and illustrates company's fine screen strainers for steam traps, reducing valves and other pipe line equipment. Tells why strainers are needed; discusses special features and construction details of these strainers. Includes pressure and screen data tables, suggestions for installing, and dimensions, weights and prices. Yarnall-Waring Co.

HEATERS, HEATING

216 **Packaged Heat**—Unit heaters featuring low first cost, easy installation and continued low cost per Btu are presented in this 12-pp booklet. Text explains how these packaged heaters are designed to operate instantly on oil or gas, fit heat output to requirements of day, and provide heat where it's wanted. Illustrations include photos of heaters and several installations and many sketches showing advantages and construction details. Prat-Daniel Corp.

217 **Tubular Heat Exchangers**—Bulletin 916, 32 pp, describes present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

218 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

219 **Tubular Heater**—A simplified vertical tubular heater suitable for every process duty and designed to hold initial and maintenance costs to a minimum, is the subject of 4-pp Bulletin 0-46-7. Includes a complete description of this simplified design which features the use of bare tubes and the absence of any metal parts exposed to furnace gases, also a discussion of the design's advantages. Cutaway drawings illustrate text. Foster Wheeler Corp.

220 **Condensate Drainage Control**—Manufacturer's system of high-pressure and high temperature condensate drainage control is fully explained in 24-pp Publication No. 3250. Contains useful data on steam flow conditions and heat exchange characteristics. Gives material and operating specifications and capacity ratings for both standard and high differential units in six sizes from 3 to 25 hp based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capacities for each unit tabulated for unit inlet pressures. Illustrations include photographs and dimensional drawings in color showing design and construction of both types of units. Cochrane Corp.

221 **Combustion Catalysts**—Bulletin 36, 4 pp, explains the action of company's combustion catalysts, including one type developed for use in coal-fired furnaces and another for use in oil-fired furnaces. Tells how they help to remove soot, control smoke and alleviate the slagging problem in boiler furnaces. Also describes a simple hopper-type feeding device available for spraying the catalyst into coal-fired furnaces. National Aluminate Corp.

222 **Unit Heaters**—Illustrated Bulletin TH-2, 8 pp, covers a heater which is driven by a steam turbine, the exhaust from the turbine being piped into the heater section for heating the air. Complete details of the design and construction together with engineering data and dimensions both on the revolving discharge units and the fixed discharge units are included as well as a table on mounting heights and coverage. Piping details are also shown. L. J. Wing Mfg. Co.

WATER TREATING, CORROSION PREVENTION

223 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

224 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

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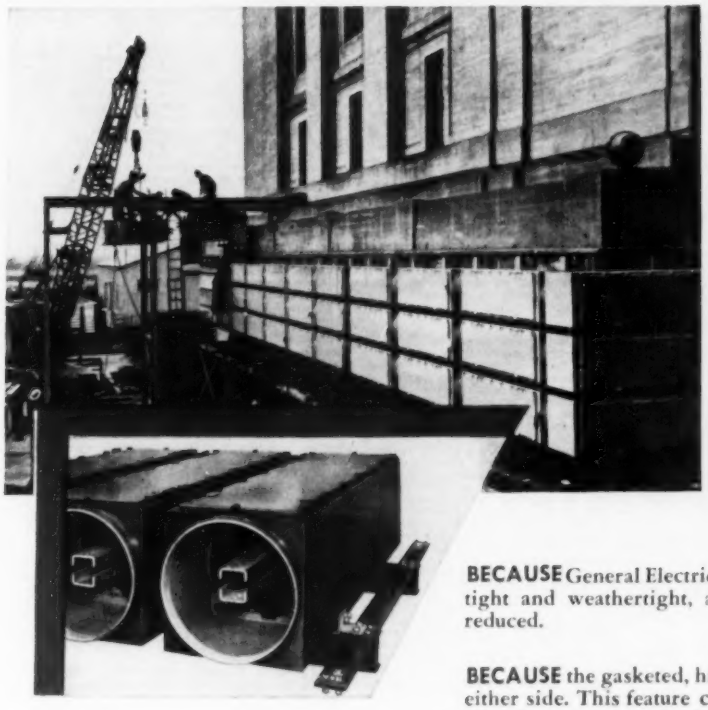

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GENERAL ELECTRIC

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225 **Corrosion Resistance of Nickel Alloys** —Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 55 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

226 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

227 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

228 **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in **Betz Technical Paper No. 111** titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

229 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 3BH7036. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

230 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 123. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing. %Proportioneers, Inc.%

231 **Water Softener Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2388, 12 pp, describing ion exchange equipment. It covers in detail down-flow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners and includes detailed, illustrated discussion of multiport valves used in them. The Permutit Co.

232 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

233 **Chemical Feed Systems — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811.** It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps and a typical packaged installation. Milton Roy Co.

234 **Modern pH and Chlorine Control** —The new ninth edition of this 100-pp illustrated 6 by 9 in. paper-bound booklet has been revised to conform with the latest developments and most modern practice in water treatment. But it is much more than a catalog, although it does give full technical details of all the color comparators and equipment in water testing and control of boiler and industrial process water manufactured by this company. Its most important feature, however, is inclusion of much good technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining constituent impurities in water; applications of water control in air conditioning; treatment of boiler feed water and industrial water, and other industrial applications. Descriptions of color comparators are detailed and illustrated, with the prices listed; and include a new testing set for total hardness of water (technical details given in article in January, 1950, issue of POWER GENERATION). W. A. Taylor & Co.

235 **Water Softeners**—Bulletin WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. The two basic designs and operation of company's hot process softeners are described, together with six adaptations of each design to various plant conditions, such as per cent make-up, treatment of condensate, deaeration. Methods of supplementary hot phosphate treatment are also discussed. Includes more than 30 diagrams of hot process designs and flow charts, together with photographs of installations. Graver Water Conditioning Co.

236 **Boiler Water Treatment** — Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used, feeding and testing equipment, and service. National Aluminate Corp.

ELECTRICAL

237 **Large D-C Motors**—Latest construction features of manufacturer's large d-c motors for applications requiring wide speed variation and fine speed control are discussed in 40-pp Bulletin OB56002A. Included is a comprehensive description of "frog leg" armature windings, a combination wave and lap winding that gives good commutation without cross-connectors and views of the new style mill-type spherical seated thrust bearing with welded-steel pedestal for heavy service. Controls for the motors, currently being used to drive metal rolling equipment, mine hoists, paper machines rubber mill rolls, plastic calendars and traction equipment are also covered. Allis-Chalmers Mfg. Co.

238 **Synchronous Generators**—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 900 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

239 **Synchronous Motors — High speed synchronous motors are described in** 4-pp bulletin PB 5000-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

PUMPS, COMPRESSORS, ENGINES

240 **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the governor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

241 **Condensers**—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

242 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

243 **Air Compressor Lubrication Manual** —Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

244 **Steam Pumps — This is manufacturer's collection of bulletins** covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

245 **High Vacuum Apparatus** -- This 50-pp handbook, Bulletin 10A, covers vacuum pumps and accessories and furnishes excellent engineering data on planning high vacuum systems. Contains illustrations, specifications and dimensions for many types of vacuum pumps, gages, burners, lubricants and other accessories. Prices and ordering information included. Central Scientific Co.

INSTRUMENTS AND CONTROLS

246 **Smoke Density Recorder** — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

247 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type PH integral furnace boiler is presented and other drawings and photographs show accompanying equipment. Northern Equipment Co.

248 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

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CAUSED BY
IMPURE STEAM

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ANTI-FOAM
KEPT THIS PIPE
FREE FROM SCALE

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This recent Dearborn development reduces foaming . . . prevents carry-over and consequent deposits of scale which may foul superheater tubes, turbine blades, valves and cylinders . . . conditions sludge . . . is compatible with other boiler water treatment.

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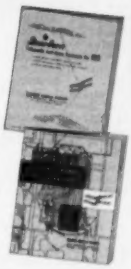

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250 Temperature Measuring Instruments—For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialised instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

251 Recording Instrument Data Book—An oxygen-analyser, based on the para-magnetic property of oxygen, is described and illustrated in Bulletin 49-820, 16 pp. Tells advantages and applications of the instrument; also discusses manufacturer's analyser for carbon dioxide and other gases and an electronic recorder (temperature and pressure) for use with analyzers. Describes several recommended gas sampling systems. The Hays Corp.

252 Metering Chlorine—Bulletin 840-P2 describes an instrument designed to accurately meter chlorine gas and deliver a chlorine water solution to the point of application. Discusses the safety and other features of the instrument and explains its operation and maintenance. Illustrations include photos, a phantom drawing showing principle working parts, and a layout diagram. Builders-Providence, Inc.

253 Purity Indicator—An instrument for measuring and indicating electrical conductance of steam and water is described and illustrated in 4-pp Bulletin 23-48 RCU. It discusses problems encountered with steam and condensate purity and cites examples of how controller and alarm assembly are utilized in detecting and signalling impurities caused by carry-over and condenser leakage. Includes photos of typical test apparatus, also prices. E. F. Drew & Co., Inc.

254 Flow Meters—Illustrated Bulletin M-51, 4 pp, explains how automatic compensation for pressure or temperature variations, or both, are achieved in flow measurement of gases or liquids with company's compensated meters. A schematic diagram shows how a corrected record is automatically and continuously produced, with the chart also showing uncorrected flow. Another diagram illustrates installation of a pressure and temperature compensated flow meter, and photos show the meters equipped for compensating functions. Hagan Corp.

255 For Practical Men—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. Discusses the Megger as a trouble-shooter, pointing out its functions and telling how to get the most out of it. There's also a chapter on testing equipment. Photos, line drawings and humorous sketches accompany the text. James G. Biddle Co.

COAL HANDLING

256 Screw Conveyor—Two-pp Form A-84 describes a high-speed, direct-feed, bin-to-stoker screw conveyor that comes ready to set up. Illustrations show this conveyor in use and detail of its principal parts. Stresses economy of this conveyor in handling coal and includes specifications. Baughman Mfg. Co., Inc.

257 Coal Scale Data Book—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

258 Spreader Stoker Selection—Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

259 Coal Crusher—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co.

260 Spreader Stokers—Catalog 80, 44 pp, describes a spreader stoker with forward moving grate that slowly and continuously discharges ash at the front. Explains the efficiency and economy of this stoker, illustrating grate's design and operation. Includes discussion of typical power plant installations of these stokers, covering more than 30 industrial, institutional, municipal and public utility installations through the country. These are illustrated by photos and blueprint drawings of the stokers as well as photos of the plants where they're used. Detroit Stoker Co.

261 Coal Handling Equipment—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Also describes and illustrates a skip hoist and other auxiliary equipment. Gifford-Wood Co.

262 Spreader Stoker—Bulletin SB 31, 4 pp, explains and illustrates, by photos, the design and construction features of company's spreader stokers, stressing their advantages. Also contains photos of several installations. Erie City Iron Works.

TURBINES

263 Turbine Catalog Collection—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

264 Velocity Stage Turbines—Catalog 52-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described in detail. De Laval Steam Turbine Co.

265 The Answers on Turbine Oil—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

DUST COLLECTING

266 Fly Ash Elimination—Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Parts and assemblies are illustrated by photos and drawings and explained in terms of construction, operation and capacities. Particle size and its significance in fly ash elimination, is discussed in detail and so is dust collecting efficiency as affected by operating conditions. Book also contains excellent engineering data on single and double hopper installations and several diagrams of typical arrangements. Western Precipitation Corp.

267 Dust Collectors—Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1433, 28 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

FUELS, LUBRICANTS

268 Steam Power Plant Auxiliaries—In Vol. 36, No. 4, of Lubrication, a technical publication on selection and use of lubricants, is an article of recommended lubrication practices for steam power plant auxiliaries. Illustrated with photos and sketches, it discusses automatic coal firing machinery, stoker design, pulverizers, tube cleaners, compressors, motors, fans and blowers, external reciprocating elements of pumps and compressors and similar subjects. The Texas Co.

269 Diesels, Their Fuels and Lubricants—This 48-pp book offers a well organized and attractive presentation of practical information on Diesel engines, covering their history and economics as well as discussing their design characteristics and operating principles. Classification of Diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and Diesel oil purification and filtration. The balance of the book is devoted to a discussion of fuel and lubricating oil required by Diesels and description of company's products. Book is filled with photos, sectional illustrations and schematic drawings and includes table showing relation of engine performance characteristics to fuel properties. Sinclair Refining Co.

MISCELLANEOUS

270 Pump Packings—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

271 Concrete Floors Q & A—A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

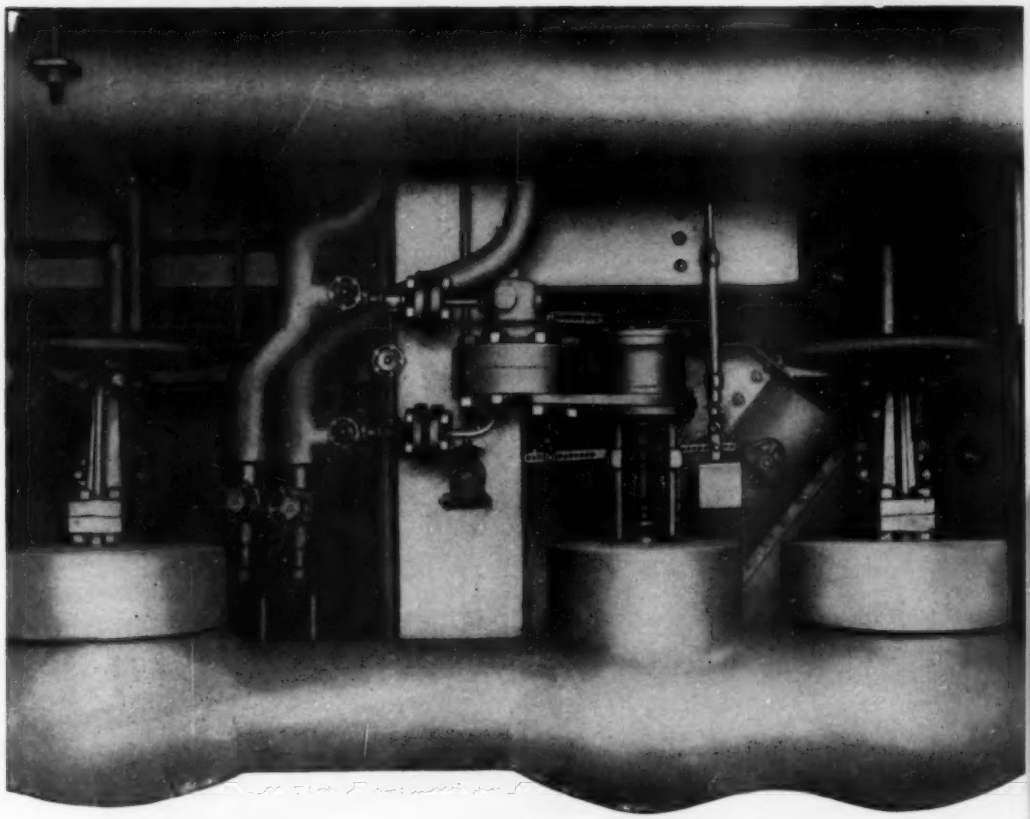
272 Tube-Ice Machine—Bulletin TI-3 describes manufacturer's automatic ice-making machine for producing either cylinder or crushed ice. Explains and illustrates machine's operation, discussing its small space requirement, quick freezing time, reduced power consumption and economy. Its application in the dairy and packing industries, breweries, chemical plants, institutions, and ice plants are described and pictured. Also discussed is the utilization of this machine in cold water refrigeration for air conditioning systems. Includes chapter on the handling and storage of ice. Henry Vogt Machine Co.

273 Purger Bulletin—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 8-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Armstrong Machine Works.

274 Water Hardness Test—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

275 Car Spotter—Book No. 1992-A, 16 pp, illustrates and describes car spotters in three types and two sizes for a variety of car moving jobs, many of which are illustrated by photos. Book contains photos of various models, dimensional drawings, electrical characteristics, weights and prices. Also covers accessories for use with spotters—rope, hooks, sheaves

(Continued on page 110)



How to hold boiler water level closely

When you want to hold boiler water level within close limits, no matter how widely or rapidly loads change, depend on COPES Flowmatic—the simplest, most widely used flow-level type of feed control.

This industrial installation, for example, is on a 660-psi Riley Steam Generator rated at 225,000 pounds per hour. Loads constantly fluctuate 10,000 pounds per hour over a total range from 150,000 to 265,000 pounds per hour. Yet water level is held within plus-or-minus one inch at all times.

More than 1200 Flowmatic users like the coordination of influences from steam flow and water level to get the exact feed needed for close level control. They also like the ease with which plant personnel can handle all maintenance.

For a complete performance report on installation illustrated above, write for Bulletin 485.

NORTHERN EQUIPMENT CO.
602 Grove Drive, Erie, Pa.
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COPES

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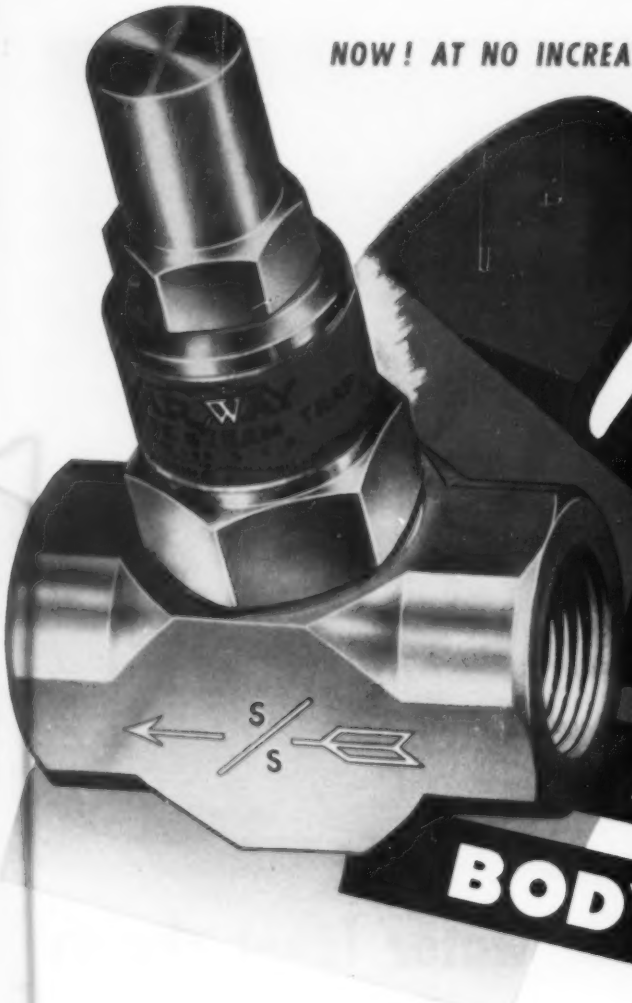
Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

NOW! AT NO INCREASE IN COST TO YOU



NEW!

STAINLESS STEEL BODY

Makes a good steam trap better

Nearly 650,000 Yarway Impulse Steam Traps have already been installed—proof that they are doing a good job.

Now a *stainless steel* body makes this famous little trap even *better—at no increase in cost.*

Better in *wear*, better in *service*. Users will find Yarways require less maintenance than ever. All parts are wear-resistant, practically wear-proof. There is only one moving part, a small, stainless steel, heat-treated valve. Important, too—Yarway Impulse Traps are *suitable for all pressures up to specified maximum without change of valve or seat.*

Other popular advantages are *small size, light weight, easy installation* and *low cost.* Often it costs *less* to buy a new Yarway trap than to repair an old, ordinary trap.

In performance—ask any user. They all say Yarways are the traps that *get equipment better sooner and keep it hot!*

For better steam trap performance, try *new* stainless steel Yarways.

YARWAY IMPULSE STEAM TRAPS ARE SOLD BY OVER 200 DISTRIBUTORS. THERE IS ONE NEAR YOU.

Write for name and address.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.

YARWAY IMPULSE STEAM TRAP

LETTERS TO THE EDITORS

HE LIKES EVERYTHING

I HAVE JUST FINISHED reading the last issue of the magazine under its new title. It will admit that I was not favorable to the title POWER GENERATION, because the field of "power" includes engineering, construction, operation and generation, transmission, application, and an extensive list of allied interests.

I am in favor of the new front cover index, for the reasons given. Also the form of the title page 5, where the list of names, addresses, etc., is in such form that the data given are readily accessible.

Also, I am in favor of the "Practical Engineer" section. All articles under this heading should be grouped together under one heading.

HOWARD T. LIVINGSTON
Los Angeles, California.

ATOMIC POWER

PUBLIC DISCUSSION of the H-Bomb has again focussed attention on the destructive properties of atomic reactions and their military consequences.

One sad result is the "brush off" given to the power producing abilities of nuclear fission.

Yet in the final analysis, atomic power is going to decide any future combat between nations; while the atom bombs may probably be shelved for fear of retaliation, as was poison gas in the last war.

Visualize a fleet of aircraft with an unlimited cruising range operated by remote control. Consider a fleet of submarines which need never come up for air, having a cruising range limited solely by the food carrying capacity, and you can well imagine the defensive and offensive abilities of atomic power from a military standpoint.

But even so, atomic power has greater importance. During the last war, we were all impressed by the limitations set up by shortage of fuel, despite the abundant resources available. The bottleneck lay in the delivery of fuel from the areas where it was produced to industrial centers. Tankers, the chief pre-war carriers were needed for overseas operations. Pipe lines and land carriers could not carry the load at a time when all transportation facilities were strained to the peak.

Atomic power plants would require no transportation of fuel. Their location would be independent of nearby highways or rail heads; although as presently envisaged, they might require large quantities of water for cooling purposes.

Since efficiency of atomic power plants would be measured by size of installation and not the ratio of fuel to power, longer transmission line networks would be feasible opening up hitherto undeveloped areas to industrial production.

The entire industrial revolution of the nineteenth century proceeded from the utilization of steam as a prime mover. The nation which first puts atomic power to work may well achieve as great a step forward. In such a race, can we afford to come out second?

New York, N. Y. HOWARD I. PODELL

SMOKE ABATEMENT

EVERYONE seems to be talking about the nuisance of smoke and the by-products of combustion. A small group of serious-minded officials in many cities are endeavoring to correct a condition that has been growing for years and suddenly the public wants complete relief. That is a tremendous order, one that is impossible to accomplish overnight. A number of cities have instituted an annual inspection program for all combustion equipment and the results are manifold.

Hazardous installations are brought to light, not only in older and rundown buildings, but in what are considered better areas. Faulty and improperly designed equipment has been installed with no regard for the requirements it may be called upon to meet. Controls, in many cases, are non-existent, or have been neglected until they no longer function. The cost of fuel has risen steadily, and, in an effort to save money, cheaper fuel is purchased. In many instances units are fired with coal which the installation cannot be expected to burn with any great degree of efficiency. The equipment has been neglected, maintenance is practically forgotten, and replacement of parts, or equipment, is made only when the need is urgent and immediate.

A smoke abatement program costs money. The first objective therefore, is to show the public that the program can and does produce results in improved atmospheric conditions. The next is to convince everyone that a large amount of co-operation is needed and that the only way to success is to have every member of the community get behind, and heartily support it. A municipal ordinance with enough "teeth" to enable it to be carried to a successful conclusion is necessary. The daily papers can give a program great support, not only by reporting progress, but by offering truly constructive criticism. No man, no group, and no program can be infallible. Only by an honest, sincere belief in air pollution control by every member connected with the work, can a complete success be attained.

The heads of the department should be well qualified, by training and experience, to render the proper decision in any instance. The field staff should have a background of experience fitting them to correctly diagnose each individual installation. They should attend frequent training sessions covering the different types of equipment and controls they will inspect. The inspection should include any combustion device, whether it furnishes power or consumes waste and rubbish. Fumes may be just as objectionable as smoke, and in some instances they are far more harmful. On the optimistic side we find many large corporations are spending large sums to reduce emissions from their plants, and, strange to say, many have found a new source of revenue that more than pays for the initial expense. New, and previously unknown, products have been found that have a ready market. Manufacturers of combustion equipment have spent huge amounts of money to extract heat from the fuel and in some cases this has led to a marked reduction in the production emitted. Existing installations will be with us a long time. It would be economically unsound to compel the replacement of these units with new and modern equipment. American manufacturers have built a lot of service into these plants, and we must live with them until they have served their period of usefulness, but in the meantime many faults can be corrected.

In the years to come there should be a marked improvement. Wherever the problem has been attacked in an honest and intelligent manner that has been the result. It will not happen in a day or a month. It will be gradual, but the progress should be steady. New problems will arise with new industries, but an alert staff will foresee many of them before they occur and take the proper steps to overcome, or at least minimize them. Many new plants now being built outside the limits of cities with smoke abatement programs are co-operating to the extent of meeting the requirements of existing ordinances even though these new plants are legally exempt. To be sure, this is not always the case.

Smoke has always been condemned, and has been cited as a

(Continued on page 69)

El Centro Steam Station

of the Imperial Irrigation District

The first section of this station, a 20,000-kw quick pick-up unit with a 2000-kw auxiliary turbine-generator, went into service in April 1949, a little over a year ago. El Centro is interesting for a number of reasons, first because of its location, away from a constant source of cooling water, and second because of the conditions under which it operates. Steam conditions at the throttle are 600 psi and 825 F. Fired by gas or oil, the 260,000 lb per hr boiler has a large water capacity and is equipped with a dry steam drum for the quick pick-up. Unusual foundation problems were encountered due to extremely poor soil bearing pressures

By W. K. **BROWNELL**, Gibbs & Hill, Inc., Los Angeles, California

THE IMPERIAL IRRIGATION DISTRICT, a public corporation, serves the Imperial Valley in Southern California with both irrigation water and power. Water is taken from the Colorado River and flows by gravity via the All-American Canal. Irrigation water flows north through the Valley through three major canals and a system of laterals. Drainage and a small amount of excess irrigation water empties into the Salton Sea. The amount of water permitted to enter the Sea is limited by the rate of evaporation to avoid raising the sea level and flooding valuable adjacent agricultural lands. Paradoxically, during rainy periods the hydroelectric stations of the District at Drops Nos. 3 and 4 on the All-American Canal are not available as there is no demand for irrigation water. If water were permitted to flow through the canal it would raise the level of the Sea.

In addition to the power supplied by the hydroelectric stations on the canal, the District purchases power from the United States Bureau of Reclamation which is delivered over a 170-mile transmission line from Parker Dam on the Colorado River. A 20,000 kw steam-electric unit was authorized under the 1945 Power Development Project of the District to firm the hydroelectric stations and instantaneously pick up interruptions to the Parker supply.

A site for the plant was selected just outside the City of El Centro, an important load center, and near the junction of major system transmission lines and irrigation canals.

Artificial cooling of water for condensing was mandatory since there is no suitable supply of firm water in the Valley. To ensure the supply of water for the cooling tower, make-up and general service against canal interruptions, about ten days' reserve was provided in two sections, a primary settling basin and a main reservoir. Water is conducted to the reservoirs in a lateral from the Dogwood Canal, a branch of one of the main canals. The pumphouse, which includes the water-treating and chemical storage facilities, is located adjacent to the reservoir, near the cooling tower, and is well removed from the main plant. A spur track was constructed from the Southern Pacific Railroad to the main plant. As shown in Fig. 2, the facilities are organized on the site for an ultimate expansion to four units.

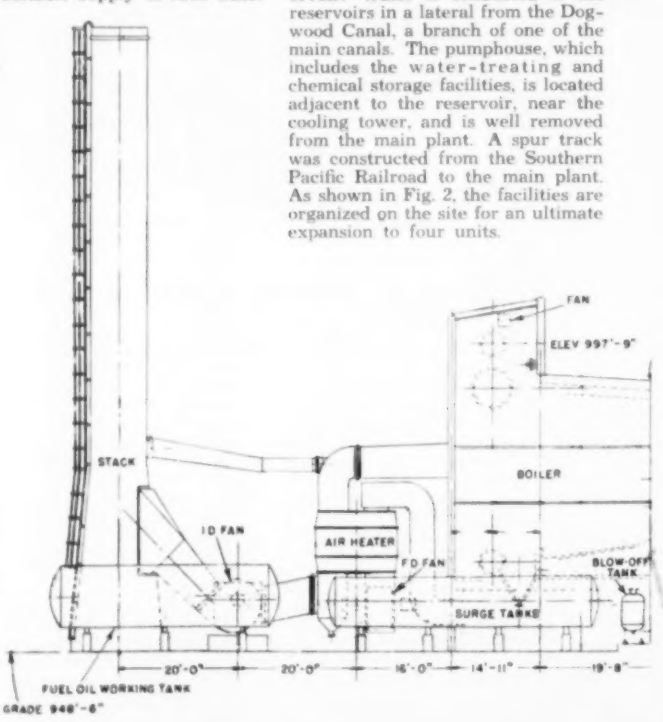


Fig. 1. Longitudinal cross section of El Centro Steam Station. The concentrated load of the equipment is distributed over a mat consisting of ribs of concrete ten feet deep with a bottom slab ten inches thick

Throttle steam conditions of 600 psi, 825 F were selected because of the extremely low load factor, about 6000 hr at a spinning reserve load of 2000 kw being contemplated.

The 20,000 kw Westinghouse turbine-generator is of the single cylinder impulse reaction type driving a 3600 rpm, 13,800-v hydrogen-cooled generator. The turbine is specially constructed for high efficiency at low loads. At full load a large part of the steam by-passes the first stage impulse wheel. This arrangement is unique in that it permits relatively small passages on the first stage with only a slight sacrifice in efficiency at full load. In addition to the usual governing apparatus, the turbine is equipped with an adjustable load limit device normally limiting load on spinning reserve to 2000 kw. Upon drop in frequency the load limit device is released and the governing valves open in approximately eight seconds to a predetermined high load limit, normally 20,000 kw. A pressure regulator is also provided, limiting the load in the event that the boiler pressure falls below 500 psi.

Because of the earthquake requirements the turbine is connected to the condenser by a rubber expansion joint. The 2-pass Allis-Chalmers condenser has a total surface of 20,000 sq ft of ⅞-in. tubes. The condenser is designed for low head room with a shallow hot well and vertical hot well pumps. Circulating water enters the condenser at the top and discharges at the bottom with the air off-takes at the top. The condenser is supplied by two vertical circulating pumps, whose capacities are 8000 and 16,000 gpm, respectively. The small pump operates singly on spinning reserve load and delivers about 10,700 gpm.

The unit is equipped with three Byron Jackson boiler feed pumps of the horizontally-split case opposed impeller type, two of which are motor driven and the third turbine driven. One of the pumps is operated on spinning reserve and the third is a spare. The pumps have stainless fits and impellers and 6 per cent chrome steel casings.

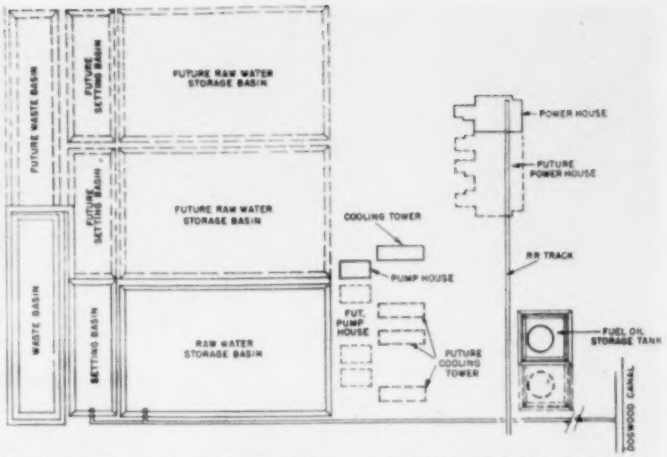


Fig. 2. Plan showing the location of the power station with respect to the water storage and settling basins and cooling tower

As shown in Fig. 4, feedwater is heated with steam extracted at three points to a final temperature of 401 F. The middle extraction heats feedwater in a Worthington open spray-type deaerating heater which is operated at constant pressure to maintain a fixed condition on the feed pumps and to have a substantial quantity of heated water available for the quick pick-up.

The other two heaters are Westinghouse closed "U" tube type, horizontally mounted with integral drain coolers. The high pressure heater is equipped with monel tubes and is of special construction to withstand the temperature shock of the quick pick-up. The evaporator vapors and drains to the deaerator. Hence, all drains are cascaded and the heaters are so elevated that the same drainage pattern functions down to no-load. Condensate is induced from and discharged to low-level surge tanks on hot well level impulse. Make-up water to the evaporator is filtered, softened with zeolite, and preheated. The regenerative cycle consists of a minimum of vessels and equipment and requires a minimum of attention for its operation. The net heat rate of the unit at full load is about 14,200 Btu per kwh and at spinning reserve is about 26,200 Btu per kwh.

The C. H. Wheeler induced draft tower cools 24,000 gpm from 113 F to 95 F, or to within 16 F of a 79 F wet bulb. The tower has five cells and is constructed of redwood throughout. The five fans are

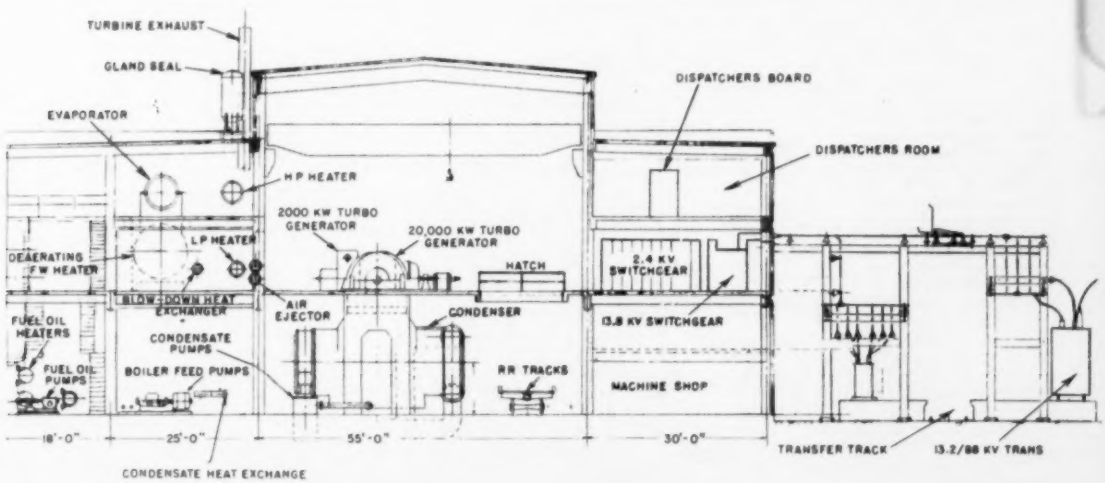


Fig. 3. An exterior view of El Centro Station of the Imperial Irrigation District

equipped with 2-speed motors for economical operation at low loads. A 9½-hr storage is provided in the concrete basin of the tower.

Make-up water for the tower is softened and clarified in a Permutit Spaulding precipitator at the pump house. Calgon threshold treatment is employed to avoid precipitation of scale in the condenser. Circulating water is intermittently chlorinated to prevent the formation of algae in the system.

In order to assure the functioning of the auxiliaries under low frequencies or low voltages during quick pick-up, a 2000 kw Westinghouse turbine-generator of impulse type driving a 3600 rpm, 2300-v generator with a top mounted air cooler is installed. If either low frequency or low voltage occurs the machine, upon either automatic or remote manual actuation, will come up to speed, build up the voltage and automatically assume the load of essential auxiliaries for two units in a period of fifteen seconds. The turbine exhausts to atmosphere and sufficient condensate storage is provided for about six hours of operation. To avoid extreme temperature changes during the quick start, the turbine is supplied with saturated steam from the boiler as are the Terry solid wheel turbines driving the spare boiler feed pump and fuel oil pump.

The unit is supplied by a Combustion Engineering Co. steam-generat-

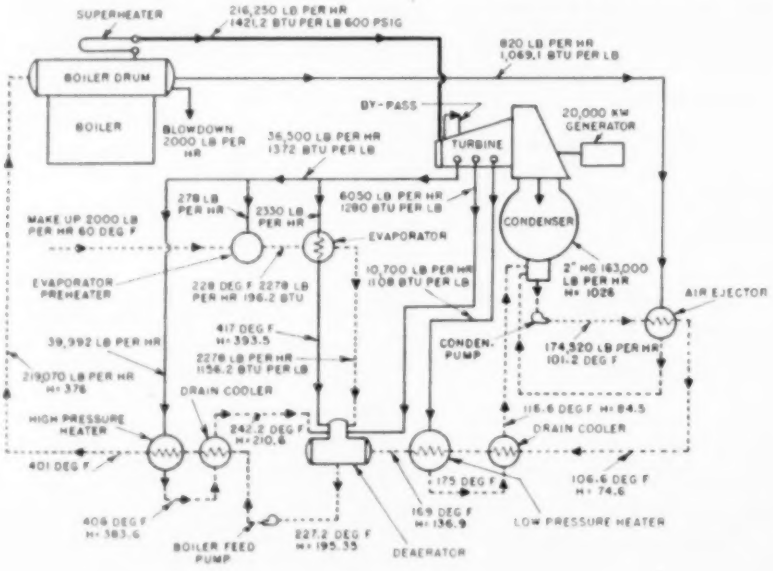


Fig. 4. Heat balance diagram. Feedwater is heated with steam extracted at three points to a final temperature of 401 F. The middle extraction heats feedwater in a Worthington open spray-type deaerating feedwater heater which is operated at constant pressure

ing unit of 260,000 lb per hr capacity, at 625 psi and 825 F. The boiler is of sufficient capacity to develop the turbine capability of 25,000 kw and to supply the main unit at 20,000 kw and the auxiliary turbine during the quick pick-up. It is a two-drum boiler with direct connected water-walled or water-cooled furnace with a maximum heat release of 33,300 Btu per cu ft per hr. To assure dry steam during quick pick-up, it is equipped with a dry drum. The boiler is coded for 750 psi pressure which permits a throttle pressure of 725 psi during spinning reserve. The boiler has sufficient water storage capacity to flash the quick pick-up requirements for a period of 30 seconds without dropping the pressure below 575 psi. To avoid retarding the circulation during quick pick-up as much of the water storage as was practicable was provided in the main steam drum, which has a diameter of 72 in. To provide for rapid expansion during quick pick-up, to avoid excessive infiltration during spinning reserve, and to avoid excessive damage from seismic shocks, the setting

Fig. 5. The main control room at El Centro

Principal Equipment - Unit No. 1, El Centro Steam Station Imperial Irrigation District

TURBINE-GENERATOR

Turbine-generator, 20,000-kw 600 psi 825 F throttle steam 2.0 in. Hg. abs exhaust, three bleed points, 3600 rpm, 13,800 volts, 3 phase, 60 cycle, 110-kw shaft driven exciter, hydrogen cooled — Westinghouse Electric Corp.
2000-kw auxiliary non-condensing turbine generator 600 psi 489 F throttle, 5 psig back pressure, 3600 rpm, 2400 v, 3 phase, 60 cycle, 33-kw shaft driven exciter, air-cooled—Westinghouse Electric Corp.
Condenser, 20,000 sq ft 2 passes—Allis-Chalmers Mfg. Co.
Condenser Tubing (phosphorus inhibited admiralty ⅞ in. by 22 ft)—Phelps Dodge Co.
2 **Circulating pumps,** 1—16,000 gpm, 64 ft, tdh, vertically driven by 300 hp, 585 rpm motor. 1—8000 gpm, 64 ft, tdh, vertically driven by 150 hp, 1160 rpm motor—Allis-Chalmers Mfg. Co.
2 **Condensate pumps,** 450 gpm, 185 ft. tdh, vertically driven by 40 hp, 1150 rpm motor —Allis-Chalmers Mfg. Co.
Two-stage steam-jet air ejector — Allis-Chalmers Mfg. Co.
Priming ejector—Allis-Chalmers Mfg. Co.
Oil purifier—Bowser, Inc.
Cooling Tower, 24,000 gpm capacity to cool from 113 F to 95 F with wet bulb of 79 F—C. H. Wheeler Mfg. Co.

STEAM GENERATING EQUIPMENT

1 **Boiler,** 2 drum type with dry drum, for dry steam during quick pick-up, 260,000 lb per hr, 625 psi and 825 F at superheater outlet, 1795 sq ft water-wall surface, 15,171 sq ft boiler surface, 9250 cu ft furnace volume, 33,300 Btu per hr per cu ft heat release — Combustion Engineering-Superheater, Inc.
Superheater, single stage interbank 3980 sq ft controlled bypass—Combustion Engineering-Superheater, Inc.
1 **Air preheater,** Ljungstrom 31,900 sq ft—Air Preheater Corp.
4 **Burners,** wide range, differential mechanical atomizing firing both oil and gas, type H-26—Peabody Engineering Corp.
Oil, 18,500 Btu per lb, carbon 85.0%, hydrogen 11.4%, nitrogen 0.6%, sulphur 1.5%, oxygen 1.0%, moisture 0.5%, viscosity at 122 F 150-200 SSF—Bunker "C."
Gas, 1113 Btu per cu ft, methane 85.2%, ethane 14.0%, CO_2 0.6%, nitrogen 0.2%, oxygen 0.0%, specific gravity (air) 0.65—El Paso Natural Gas.
1 **Forced Draft Fan,** backwardly curved, inlet vane control, high speed 96,000 cfm against 19.2 in. H_2O, intermediate speed 58,000 cfm against 8.2 in. H_2O, low speed 15,500 cfm against 2.0 in. H_2O, 2 motors 125-400 hp, 1188-1784 rpm, 15 hp, 580 rpm —B. F. Sturtevant Div., Westinghouse Electric Corp.
Induced Draft Fan, backwardly curved, inlet louvre dampers, high speed 153,000 cfm against 10.2 in. H_2O, intermediate speed 94,500 cfm against 4.5 in. H_2O, low speed 29,000 cfm against 1.3 in. H_2O, 2 motors 200-350 hp, 890-1188 rpm, 10 hp, 380 rpm—B. F. Sturtevant Div., Westinghouse Electric Corp.
Blowoff Valves—Yarway. Yarnall-Waring Co.
Safety Valves—Consolidated.
Steam Soot Blowers—Vulcan Soot Blower Co.
Water Columns—Diamond Power Specialty Corp.
1 **Constant Differential Oil Pump**—United Iron Works Co.
2 **High Pressure Fuel Oil Pumps** — Sier Bath Co., Inc.
Fuel Oil Heaters—American Locomotive Co.
Transfer Oil Pump—Sier Bath Co., Inc.
Ducts and Breeching—Lacy Manufacturing Co.
Steel Stack, (9½ ft od x 99 ft high)—Western Pipe & Steel Co.

FEEDWATER EQUIPMENT

3 **Boiler Feed Pumps,** Two 315 gpm. 1936 ft head, 3550 rpm, each driven by 250-hp motor.
One 315 gpm, 1936 ft head. 3550 rpm, driven by Terry steam turbine — Byron Jackson Co.
High Pressure Heater, 1st Extraction Point, 1600 sq ft internal drain cooler, 1000 psig water, 400 psig steam—Westinghouse Electric Corp.
Low Pressure Heater, 3rd Extraction, 740 sq ft internal drain cooler 125 psig water, full vacuum or 50 psig steam—Westinghouse Electric Corp.
Deaerator, spray type 275,000 lb per hr—Worthington Pump & Machinery Corp.
Evaporator, 10,000 lb per hr, 50 psig shell, 400 psig coil—Westinghouse Electric Corp.
Evaporator Preheater—Worthington Pump & Machinery Corp.
Evaporator Feed Pumps—Fairbanks Morse Co.

PIPING VALVES AND INSULATION

High Pressure Piping Fabricator—Midwest Piping & Supply Co.
Piping Erector—Offco Construction Co.
Insulation Contractor—Plant Insulation Co.
Non-Return Valves — Bethlehem Supply Co. of Calif.
Butterfly Valves—Henry Pratt Co.
Reverse Flow Valves (air operated)—Atwood & Morril Co.
Miscellaneous Valves—Allied Supply Co., Republic Supply Co.
Traps & Strainers—Elliott Co., Yarnall Waring Co.

INSTRUMENTS

Combustion Controls—Bailey Meter Co.
Conductivity Recorders—Leeds & Northrop Co.
Pressure Gages—Allied Supply Co.
Thermometers—Braun Corp.
Miscellaneous Instruments—Adolph Friese Co.

ELECTRICAL EQUIPMENT

3 **Main Transformers,** single-phase, 6000-kva self-cooled, 7500-kva forced air-cooled, 10,000-kva forced oil-cooled, 13,200-v delta /88,000-v wye — Westinghouse Electric Corp.
3 **General Auxiliary Transformers,** three-phase, 750-kva, 13,200-v delta, 2400-v delta —Westinghouse Electric Corp.
Air Break Switch for 13.8-kv—Westinghouse Electric Corp.
Substation Structure — Fontana Welding Works.
Switchgear and Unit Type Substations—General Electric Co.
Motors — General Electric Co., Westinghouse Electric Corp., Allis-Chalmers Mfg. Co.
Generator Neutral Equipment — General Electric Co.
Motor Starters — Westinghouse Electric Corp., Square-D Co.
15-kv Cable—Collyer Cable Corp.
5-kv Cable—Rome Cable Corp.
600-volt Cable—General Cable Corp.
Battery Charging Equipment — General Electric Co.

MISCELLANEOUS EQUIPMENT

Turbine Room Crane—Harnischfeger Corp.
Tanks—Chicago Bridge & Iron Co., American Pipe & Steel Corp.
Air Compressors—Worthington Pump & Machinery Corp.
Water Softener Equipment—The Permutit Co.
Chlorination Equipment—Wallace & Tiernan Products Co.
Miscellaneous Pumps — Fairbanks Morse Co.
Air Conditioning Equipment — American Blower Corp., York Corp.

CONSTRUCTION

Supervision—Gibbs & Hill, Inc.
Trackwork—Wm. A. Smith Contr. Co.
Excavation & Substructure—C. M. Elliott.
Structural Steel—National Iron Works.
Superstructure—M. H. Golden Construction Co.
Mechanical Installation—Brown Lane Co.
Electrical Installation—California Electric Works.
Design Engineers—Gibbs & Hill, Inc.

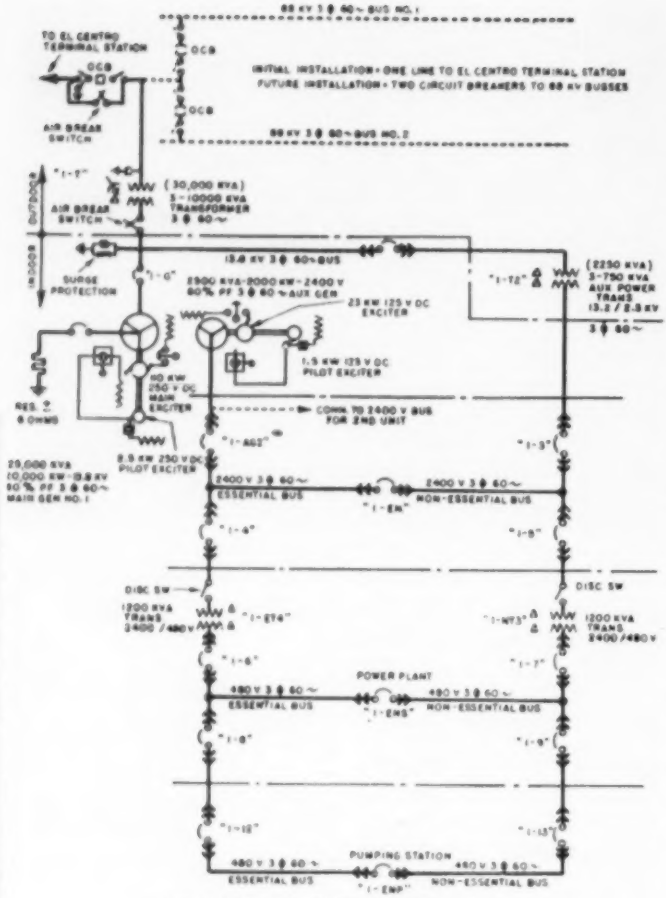

TO EL CENTRO TERMINAL STATION
OCB
AIR BREAK SWITCH
INITIAL INSTALLATION - ONE LINE TO EL CENTRO TERMINAL STATION
FUTURE INSTALLATION - TWO CIRCUIT BREAKERS TO 69 KV BUSSES
69 KV 3 Φ 60~ BUS NO. 1
69 KV 3 Φ 60~ BUS NO. 2
(30,000 KVA)
3 - 10000 KVA TRANSFORMER 3 Φ 60~
OUTDOOR
INDOOR
SURGE PROTECTION
13.8 KV 3 Φ 60~ BUS
2500 KVA-2000 KW-2400 V 80% PF 3 Φ 60~ AUX GEN
23 KW 125 V DC EXCITER
1.5 KW 125 V DC PILOT EXCITER
60 KW 250 V DC MAIN EXCITER
RES. 2 Ω OHMS
8.5 KW 250 V DC PILOT EXCITER
20,000 KVA 16,000 KW-13.8 KV 80 % PF 3 Φ 60~ MAIN GEN NO. 1
(2250 KVA) 3-750 KVA AUX POWER TRANS 13.2 / 2.3 KV 3 Φ 60~
CONN TO 2400 V BUS FOR 2ND UNIT
2400 V 3 Φ 60~ ESSENTIAL BUS
2400 V 3 Φ 60~ NON-ESSENTIAL BUS
"1-EN"
DISC SW
1200 KVA TRANS 2400/480 V
POWER PLANT
480 V 3 Φ 60~ ESSENTIAL BUS
480 V 3 Φ 60~ NON-ESSENTIAL BUS
"1-EMS"
PUMPING STATION
480 V 3 Φ 60~ ESSENTIAL BUS
480 V 3 Φ 60~ NON-ESSENTIAL BUS
"1-ENP"

Fig. 6. Main and auxiliary power connections

is of suspended wall construction, except the side walls of the furnace.

Steam temperature is controlled by dual dampers at the boiler exit by-passing the superheater surface. A manual steam soot blowing system with retractable elements is installed for cleaning the first pass and superheater. Heat recovery apparatus consists of a Lungstrom regenerative-type preheater. At an output of 210,000 lb per hr, corresponding to approximately 20,000 kw, exit gas temperature is about 329 F, and over-all efficiency is 86 per cent. Four Peabody wide range differential mechanical type burners are installed for firing residual oil and natural gas. A differential pump recirculates oil to the burners, maintaining a differential pressure of about 250 psi. The total pressure at the burner tips varies from about 300 psi at spinning reserve to 900 psi during the quick pick-up, resulting in fine atomization and a very clear fire over the wide range of 15 to 1.

The mechanical draft equipment consists of one Sturtevant backwardly-curved forced draft fan with inlet vanes and one Sturtevant radial tip induced draft fan with inlet louvers. Each fan is driven by two motors; one small, low-speed motor for spinning reserve and one two-speed motor for normal and quick pick-up operation. For normal operation, intermediate speeds of 1188 and 890 rpm for forced and induced draft fans, respectively, are used, and for quick pick-up or abnormal overloads the high speeds of 1784 and 1188 rpm are used. The high speeds provide for about 40 per cent overfiring to make up the heat deficiency in the boiler setting, superheater, and feed-water system during quick pick-up. Because of the outdoor location and frequent dust storms, the fan motors are totally enclosed and fan-cooled.

Controls

The Bailey combustion control maintains a boiler drum pressure varying from 725 psi at spinning reserve to 620 psi at full load. The master control is the dual element type, initial impulse being from superheated and saturated steam flow with secondary correction from pressure. This system maintains a predetermined fuel-air ratio for different ratings by: (1) positioning of a valve by-passing oil from the main oil pump discharge to the working tank and metering the oil flow to the burners; or (2) flow regulation of the fuel gas; together with positioning of the inlet vanes of the forced draft fans. Air flow is metered across an orifice in the hot air duct to the burners. When oil and gas are fired simultaneously, the fuel is totalized and air proportioned accordingly. The fuel oil control system is unique in that the main oil pump discharges only against the actual pressure required by the differential system. Furnace draft is maintained by positioning of the induced draft fan inlet louvres.

On quick pick-up, the drop in frequency unblocks the turbine governor and automatically switches the fans from low to high speed. In this instance, oil flow is proportioned to steam flow to expedite the response. All other fan speed changes are manually actuated and alarms indicate extreme positions of the inlet vanes or louvers. In order to expedite maintenance of the oil temperature during quick pick-up, admission of steam to the oil heaters is proportioned primarily to oil flow and steam pressure with secondary correction for oil temperature. Steam temperature is controlled primarily from air flow and secondarily from temperature. Feedwater is controlled by a three element regulator actuated from boiler level, steam and feedwater flow.

Arrangement

The equipment was arranged to realize two main objectives: first, to keep the heavy pieces at a minimum height above the foundation so as to minimize the cost of the structure required to withstand earthquake shocks; and second, to centralize the control of all primary operating equipment at one point so as to minimize necessary attendance.

Since the circulating water system was entirely under pressure, the basement level was placed just above grade so that practically all drainage from the plant would be by gravity. The height from the basement to the operating floor is only twenty feet. As shown in Fig. 1, the main turbine generator is parallel and the auxiliary turbine generator is perpendicular to the length of the turbine room. The boiler is located entirely outdoors with the burner front just inside the building off the firing aisle, all four burners being accessible from operating floor level. The air preheater is vertically mounted outdoors, with the hot air duct running under the boiler structure to the burner front. The forced and in-

(Continued on page 94)

How Filming Amines Prevent Steam and Return Line Corrosion

New approach to prevention of steam and return line corrosion based on depositing film of long-chain polar amines on metal . . . Nature of corrosion analyzed; CO_2 is usual cause . . . Deaeration eliminates O_2 in steam, but air may leak into return lines . . . Filming amines resist both CO_2 and O_2, do not require exact proportioning, cost 10 to 40% of neutralizing amines . . . How the filming amines are applied . . . Data from over 50 full scale plant applications summarized to show decrease in corrosion by this method

By **JOHN J. MAGUIRE**
Director, Technical Division
W. H. & L. D. Betz

CORROSION of steam and condensate return lines is a problem of major importance to most industrial plants. The replacement cost of corroded lines is appreciable, but is usually exceeded by the labor cost involved removing the leaking lines and installing new pipe. Frequently, buried lines must be renewed or replacement made of check valves and traps in difficult locations. Interruption in production because of steam or return line corrosion may represent an important cost item. In general, the maintenance costs associated with this corrosion problem far exceed purchase cost of the replaced lines.

Cause of Condensate Return Line Corrosion

The major cause of corrosion experienced in steam and return condensate lines is the presence of the corrosive gases, oxygen and carbon dioxide. In lines carrying superheated steam there will be no corrosion caused by oxygen and carbon dioxide. These gases are corrosive only in the presence of moisture. Corrosion will be experienced in lines carrying saturated or wet steam or in condensate lines.

Dissolved oxygen present in the steam leaving the boilers is an obvious cause of corrosion in steam and return lines. The remedy for this condition is deaeration of the boiler feedwater and the use of sodium sulfite. In most plants, these measures satisfactorily prevent the presence of oxygen in the steam produced by the boilers. Of course, while the steam leaving the boilers may be free of oxygen, air may be drawn into the return condensate system by leaks, breathing action of return tanks, use of vacuum pumps and single pipe heating systems.

Carbon dioxide is the usual cause of steam and return line corrosion, not because carbon dioxide is more corrosive than oxygen, but because carbon dioxide in steam is not prevented by deaeration of the boiler feedwater. Free carbon dioxide, that is gaseous carbon dioxide dissolved in water, is almost completely eliminated by efficient feedwater deaeration and consequently is rarely a factor in steam and return line corrosion. Carbon dioxide, produced by decomposition within the boiler of the bicarbonate and carbonate content of the feedwater, is the chief cause of steam and return line corrosion.

When the boiler feedwater enters the boiler, the bicarbonate content of the feedwater breaks down under the higher temperatures in accordance with the following reaction:

These decomposition reactions are the source of the carbon dioxide content of steam which causes corrosion by its formation of carbonic acid in the presence of moisture. Based on 100 per cent decomposition in equation 1 and 80 per cent decomposition in equation 2, for each 1.0 ppm of bicarbonate alkalinity as $CaCO_3$ in the boiler feedwater, 0.79 ppm carbon dioxide is produced with the steam. Where carbonate alkalinity is present in the boiler feedwater, such as where the make-up water is lime-soda softened, for each 1.0 ppm of carbonate alkalinity as $CaCO_3$ in the boiler feedwater, 0.35 ppm carbon dioxide will be present in the steam. Of course, the sodium hydroxide content of a boiler feed-

(1) $2NaHCO_3$ (Sodium Bicarbonate) + Heat = Na_2CO_3 (Sodium Carbonate) + H_2O (Water) + CO_2 (Carbon Dioxide)

Note that carbon dioxide is evolved and the bicarbonate broken down to carbonate. The carbonate will undergo further decomposition as follows:

(2) Na_2CO_3 (Sodium Carbonate) + H_2O (Water) + Heat = 2NaOH (Sodium Hydroxide) + CO_2 (Carbon Dioxide)

Fig. 1. Two forms of return line corrosion in condensate piping

Fig. 2. Example of thinning of pipe wall by aggravated CO_2 attack

water will not produce any carbon dioxide with the steam.

Corrosion from carbon dioxide in return line systems is characterized by a general thinning of the pipe wall or grooving along the bottom of the line. Failure usually occurs at the pipe threads since the metal is thinnest at this point. Unless oxygen is also a factor in causing the corrosion, pitting of the lines will not be noted. In some cases where corrosion is caused by both carbon dioxide and oxygen, both grooving and pitting will be observed.

Figure 1 illustrates sections of condensate piping typical of these two forms of corrosive attack. The pipe section on the left shows corrosion by carbon dioxide with the characteristic thinning of the metal wall and grooving along the bottom of the line. The section on the right shows thinning of the wall, but pitting is also evident indicating the corrosion to have been due to a combination of oxygen and carbon dioxide.

Figure 2 is another example of the thinning of pipe wall by high carbon dioxide concentrations in the condensate. As can be noted, the line has been entirely corroded through and in other sections reduced to paper thickness.

Methods Used For Prevention of Carbon Dioxide Corrosion

Both external and internal chemical treatment methods are employed to reduce the problem of carbon dioxide corrosion. External treatment methods are directed toward reducing the bicarbonate and carbonate content of the boiler feedwater. Since the chief source of carbon dioxide in the steam is the bicarbonate or carbonate alkalinity of the boiler feedwater, any external treatment method which will reduce these concentrations in the feedwater is desirable from the standpoint of minimizing carbon dioxide content of the steam.

Lime-soda softening is one method of markedly reducing the bicarbonate alkalinity of a high bicarbonate water. In operating the lime-soda softener, it is also advisable to maintain the alkalinity of the effluent on a hydroxide-carbonate balance rather than on a bicarbonate-carbonate balance.

Combination sodium-hydrogen zeolite softening is another method to reduce the alkalinity of the boiler feedwater. Acid treatment, before or after zeolite softening, will also achieve this same purpose. Some steam heating plants in an effort to minimize carbon dioxide as much as possible have gone so far as to overtreat with acid so as to completely destroy all alkalinity, pass the acid treated water through a stainless steel deaerating heater and then neutralize with caustic soda in the storage compartment of the heater. In these cases, carbon dioxide in the steam is almost completely eliminated.

Until recently the only method of internal treatment employed has been the use of volatile neutralizing amines such as cyclohexylamine, $C_6H_{11}NH_2$ and morpholine, C_4H_9NO. These amines when fed to a boiler volatilize with the steam and, being alkaline in nature, combine with the carbon dioxide in the condensate to neutralize its acidity. Unlike ammonia which acts similarly, the amines in low concentrations are not corrosive to copper and copper bearing metals. Control of treatment is usually based on feeding sufficient amine to raise the pH of the condensate to 7.0. Satisfactory reduction of carbon dioxide corrosion is obtained with the use of the neutralizing amines.

There are two chief disadvantages attendant to the use of the neutralizing amines. The first disadvantage is that these materials provide no protection against oxygen attack. While oxygen is seldom present in the steam in modern plants, many plants do encounter air leakage into the return system and use of the neutralizing amines will not prevent corrosion under such circumstances.

The second disadvantage of the neutralizing amines is the high cost of treatment. The manufacturing cost for these materials is fairly high and, due to their relatively high molecular weight, high concentrations of the amines are usually required to neutralize the acidity of carbon dioxide. Over-all cost for treatment with the neutralizing amines is one of the major disadvantages connected with their use.

Filming Amines—A New Approach To the Problem

A new principle in the prevention of return line corrosion is based on the deposition of a film of long chain polar amines on the metal surfaces. The filming amines function on a new and completely different principle from the neutralizing amines. The filming amines do not neutralize carbon dioxide. Instead, they function by forming on the metal surfaces contacted an impervious non-wettable film that acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. When the filming amines are adsorbed on a metal surface, water will not wet that surface. The film formed through the use of these amines is of substantially mono-molecular thickness and does not increase in thick-

Table I — Typical Test Specimen Data — Oil Refinery

Time of Exposure	Before Treatment: Weight Loss in mg.	Before Treatment: Average Penetration Inches per Year
2 weeks	962	0.0652
2 weeks	657	0.0445
4 weeks	1,487	0.0493
4 weeks	1,002	0.0342
Specimens Exposed 2 Weeks After Treatment Started		
2 weeks	85	0.0058
2 weeks	91	0.0062
4 weeks	195	0.0066
4 weeks	195	0.0066

Table II — Typical Test Specimen Data—Chemical Plant

Time of Exposure	Before Treatment: Weight Loss in mg.	Before Treatment: Average Penetration Inches per Year
2 weeks	503	0.0342
2 weeks	694	0.0472
4 weeks	766	0.0260
4 weeks	723	0.0245
Specimens Exposed 2 Weeks After Treatment Started		
2 weeks	27	0.0018
2 weeks	60	0.0041
2 weeks	17	0.0011
2 weeks	24	0.0016

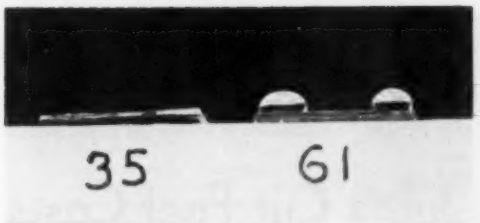


Fig. 3. Two test specimens; one on right exposed to condensate treated with filming amines, causing water to assume droplet form. Specimen on left untreated, water spreads over surface

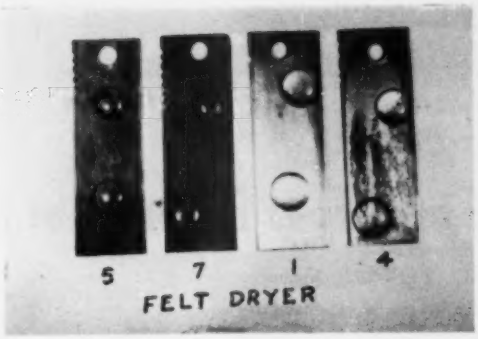


Fig. 4. Protective film developed on test specimens in plant condensate systems. Left, 2 steel specimens, right 2 brass specimens, after 30 days exposure in plant condensate system treated with filming amines

Table III — Test Specimen Data Showing Increased Protection Over 5 Month Period

Test Conditions	Time of Exposure, Weeks	Building No. 2 Weight Loss in mg.	Building No. 2 Average Penetration Inches per Year	Combined Returns Weight Loss in mg.	Combined Returns Average Penetration Inches Per Year
Before Treatment	2	30	0.0020	369	0.0250
	2	19	0.0013	443	0.0300
	4	43	0.0015	600	0.0203
	4	20	0.0010	629	0.0213
Treatment started 2 weeks before specimens exposed	2	2	0.0001	114	0.0078
	2	4	0.0003	124	0.0084
	4	2	0.0001	234	0.0080
	4	3	0.0001	238	0.0081
Specimens exposed after 5 months of treatment	2	2	0.0001	5	0.0003
	2	4	0.0003	4	0.0003
	4	7	0.0002	3	0.0001
	4	8	0.0003	1	0.0000

ness with continued treatment. The amine will penetrate corrosion products present on a metal surface and deposit a protective film on the metal. While continuous treatment is advised, the adsorbed film on the metal surface is quite durable and is not removed by short periods of discontinued treatment.

Figure 3 is a photograph of two test specimens on which a few drops of water have been placed. The specimen on the right has been exposed to condensate treated with the filming amines and it can be noted how the amine film causes the water to assume droplet form. The untreated specimen on the left does not repel water and the water spreads over the surface.

Figure 4 shows two steel specimens on the left and two brass specimens on the right after 30 days exposure in a plant condensate system treated with the filming amines. The water repellancy of the specimens is shown by the spherical form assumed by the drops of water.

Unlike the neutralizing amines which must be fed in direct proportion to the carbon dioxide concentration of the steam, a feeding rate of 15-30 ppm of the filming amines is usually sufficient to establish and maintain the desired corrosion resistant film on the metal surfaces. Consequently, except at low carbon dioxide values such as 5 ppm or less the filming amine treatment is considerably more economical than the use of the neutralizing amines.

The filming amines of value in the prevention of corrosion are the high molecular weight amines, amine salts and amine oxides having straight carbon chains containing ten to eighteen atoms. Octadecylamine ($C_{18}H_{37}NH_2$), hexadecylamine ($C_{16}H_{33}NH_2$) and dioctadecylamine ($C_{36}H_{74}NH$) are examples of the most useful materials. In plant practice the most successful results have been obtained with the dispersed octadecylamine.

Permacol is the trade name of the commercial dispersion of octadecylamine in which the insoluble amine is processed and emulsified so that dispersion and feeding from water solution is possible. This dispersed form of the filming amine is applied to steam and return line corrosion problems by feeding with a small chemical pump to the main steam line at a point where it will be well mixed with the steam. The material readily disperses with the steam and is carried through the steam and condensate lines forming a non-wettable film on the metal surfaces contacted.

Outstanding advantages of the filming amine treatment in comparison to the neutralizing amines are:

1. The adsorbed amine film is resistant not only to attack from carbon dioxide, but also to attack from oxygen.
2. Exact proportioning of chemical treatment is not required due to the durability of the adsorbed amine film.
3. The cost of treatment with the filming amines is only 10-40 per cent of the cost of the neutralizing amines for most industrial return line corrosion problems.

Table IV — Test Specimen Data from Plants of Varying Operation Characteristics

Plant	Operating Pressure psig	Steam Production lbs./day	CO_2 in steam, ppm	Average Penetration, Inches/Year Before Permacol Treatment	After Permacol Treatment	% Protection
A	400	700,000	23	0.0300	0.0060	80
B	250	500,000	21	0.0222	0.0018	92
C	125	1,500,000	30	0.0082	0.0016	80
D	110	400,000	30	0.0241	0.0002	99
E	335	550,000	14	0.0308	0.0021	94
F	300	2,000,000	49	0.0483	0.0062	87
G	150	450,000	75	0.0032	0.0005	84

Plant Results

A wealth of pilot plant data was secured on the outstanding corrosion inhibition properties of the filming amines prior to actual field application. These data have been confirmed by results secured in over 50 full scale plant applications.

Evaluation of plant results secured with the filming amines has been made through careful records of maintenance and line replacement costs and also from data secured by exposure of test strips at representative points in the condensate system. In general practice test strips have been exposed in duplicate over two and four week intervals, both before and after applying treatment.

Usually, test specimen data have shown an immediate marked decrease in the corrosion rate with the application of the filming amines. Tables I and II illustrate the prompt reduction in corrosion at two different plants with specimens exposed only two weeks after Permacol treatment was started. In each case

(Continued on page 69)

FOR THE DIESEL OPERATOR

Dual Fuel Engines at La Junta Cut Fuel Costs

Municipal plant at La Junta, Colorado, installs new 2000-hp dual fuel engine as a result of favorable operation with an older engine which was converted to dual fuel operation over a year ago. Conversion of remaining engines in the plant to dual fuel operation is expected to save some $50,000 a year in fuel costs

By **WILLIAM H. GOTTLIEB**
Morrison-Gottlieb, New York, N. Y.

CONVERSION of its Diesel engines from straight oil to dual fuel operation, it is estimated, will effect a saving of about $50,000 a year in the cost of fuel at the La Junta, Colorado, municipal power plant. This estimate is based on the operating experience with a 1750-hp, 10-cylinder, 16 by 20-in., Fairbanks Morse Diesel engine in this plant which was converted to dual fuel operation a year ago.

The successful use of dual fuels with this engine has resulted in the establishment of a program which will have as its object the conversion of the older engines in the station to dual fuel operation also. This development program included the installation of a new 2000-hp Fairbanks Morse dual fuel engine, bringing the capacity of the station up to 6725 hp. The new engine went into service in December, 1949.

Natural gas with a heat value of 900 Btu per cu ft is delivered to the La Junta plant at 50 psi. This gas pases through an individual meter and pressure regulator for each engine, where the pressure is reduced to 15 psi.

Before reaching the engine, the gas must pass first through a safety cut-off valve actuated by engine lubricating oil pressure. This valve admits gas only if the engine is turning over fast enough to bring lubricating oil pressure to operating level, if pilot oil pressure is adequate to insure combustion, and if engine speed is not excessive. The gas next passes through an admission valve controlled by governor linkage, through a header along the cylinder heads, and finally through cam-actuated valves into each cylinder. The valve lift and timing at the cylinders are constant and only the pressure in the gas header (controlled by the governor) regulates the quantity of gas injected.

The charge of pilot oil which initiates combustion does not vary in quantity and is injected by a separate small-volume fuel pump for each cylinder, permitting a precisely regulated supply. The engine also is equipped with standard Diesel fuel pumps which function when the engine is operating wholly on oil and cut in automatically to compensate for any gas deficiencies during dual fuel operation. Both pumps use the same injection nozzle.

To insure a favorable gas-air ratio, a governor-regulated valve controls the quantity of scavenging air admitted to the cylinders. The gas and

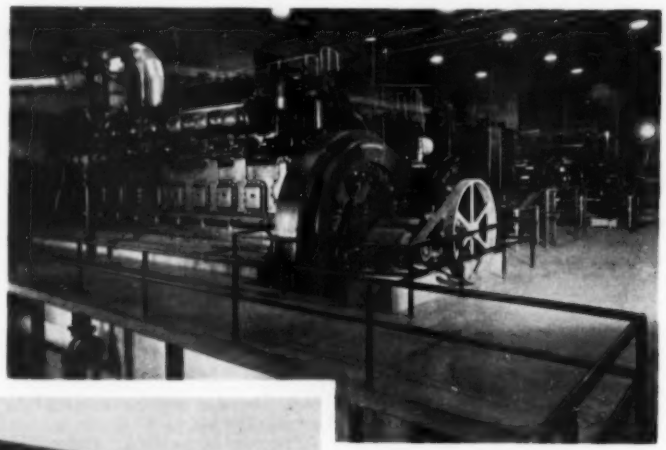


Fig. 1. (Right) A view of the engine room at La Junta. There are five Fairbanks Morse engines, totaling 6725 hp. In the foreground is the new 2000 hp dual fuel unit and at the far right is the 1750-hp engine which has been converted to dual-fuel operation

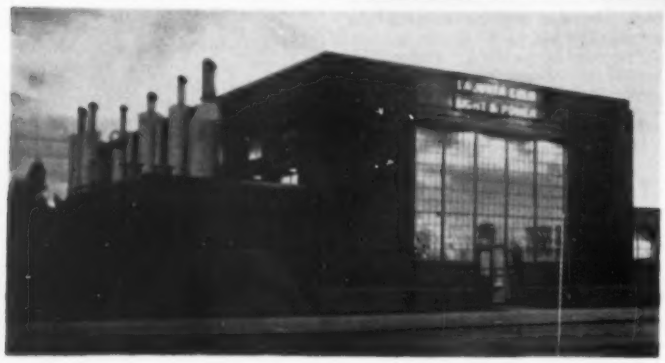


Fig. 2. (Below) A night view of the La Junta plant showing the Maxim silencers

air supplies are separate entities, independently controlled, so that there is always sufficient air for full combustion even with gases of low Btu content like sewage gas. Also, the physical isolation of the gas system at the top of the engine is an added safety factor.

Like the fortunate prospectors who found rich ore in Colorado, La Junta has made pioneering pay profits. The city cooperated fully with the engine builder's design engineer in the development of the first 16 by 20-in. dual fuel unit. Yet, even that period of development and adjustment resulted in a 50 per cent reduction in fuel costs, a solid saving of more than $15,000.00 for the first year on that one unit's operation.

In 1949, the 1750-hp engine was the mainstay of the plant, operating virtually all the time and producing close to 6,000,000 kwh. Costs of gas and fuel oil for this unit were cut steadily throughout the year down to 4 mills per kwh. Further refinements are expected to bring the conversion to the full efficiency of a new dual fuel.

The new 2000-hp engine was first put to work on Dec. 8, 1949. By March 13, 1950, the unit had run 1120 hr and generated 1,096,300 kwh.

Lubricating oil is cleaned continuously by circulation through a filter with cotton-waste elements. The full pressure lubrication system which supplies the bearings and cools the pistons includes an engine-driven pump and a shell-and-tube cooler. A motor-driven auxiliary pump is used to circulate lube before starting and after shutting down the engine. Fuel oil is passed through a cotton-waste filter before the day tanks and also through a special filter on the engine to protect the pilot oil pumps.

Scavenging air for the big engine is drawn through a battery of four oil-bath air filters and supplied to the engine by a blower driven by a 125-hp motor. This motor is powered directly from the engine-driven alternator. A 48-v wet cell battery forces the field of the alternator, insuring a quick supply of power to drive the blower when the engine is started. Engine exhaust gases vent through vertical silencers at the side of the plant.

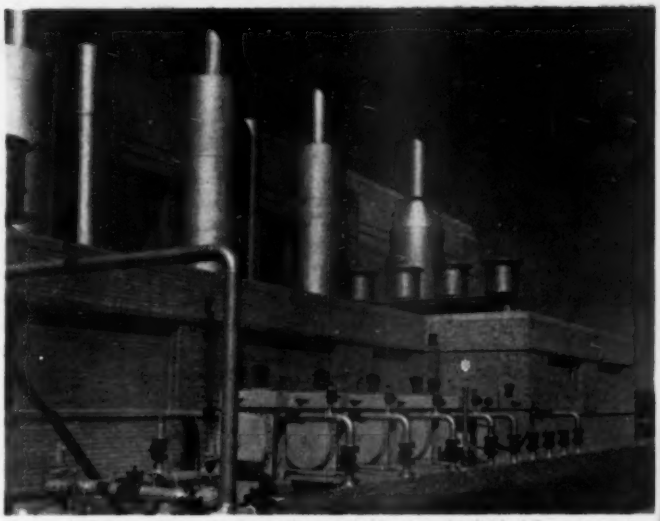


Fig. 3. All of the engines at La Junta will use natural gas, and individual Emco gas meters and regulators have been provided for each engine. This view also shows the Air-Maze filters and the Maxim silencers

La Junta's 58 grain water is softened in two hot wells and circulated by five motor-driven centrifugal pumps through the engine jackets and the coils of a three-section forced-draft cooling tower. Four additional pumps handle the raw water for the tower.

Separate records are kept of operation, production, fuel and lubricating oil consumption, and maintenance work and expenditures for each engine in the plant and serve as a guide to intelligent and economical operation. That kind of operation is paying off handsomely in benefits to the plant's collective owners. The records indicate that conversion to dual fuel will raise profits and attendent benefits to new heights.

The utilities system is managed by D. J. Goodhue under the supervision of a Power Board consisting of Mayor M. B. Chase, three members elected for six-year terms, and a representative of the City Council.

* * *

Principal Equipment Serving New Engine in La Junta Municipal Power Plant

ENGINE: 2000-hp, 16 by 20-in, 300 rpm, Model 33FD16 dual fuel engine. Fairbanks, Morse & Co.
ALTERNATOR: Fairbanks, Morse & Co.
GOVERNOR: Woodward Governor Co.
SCAVENGING AIR BLOWER: Roots-Connersville Blower Corp. blower driven by Fairbanks Morse electric motor.
LUBE FILTER: Midwest Filter & Mfg. Co.
LUBE COOLER: Ross Heater & Mfg. Co.
AUXILIARY LUBE PUMP: Geo. D. Roper Corp.
AIR FILTERS: Air-Maze Corp.
EXHAUST SILENCER: Maxim Silencer Co.
COOLING TOWER: The Marley Co.
COOLING WATER PUMPS: Fairbanks, Morse & Co.
FUEL FILTER: Midwest Filter & Mfg. Co.
GAS METER AND REGULATOR: Emco.
EXHAUST PYROMETER: Brown Instrument Co.
SWITCHBOARD: Westinghouse Electric & Mfg. Co.

Table I. Operating Expenses of La Junta Municipal Plant

Year Ending June 30	Total Operating Revenue	Supervision and Labor	Fuel	Lube	Water	Supplies	Maint.	Total Plant Operating	Total Expend. incl. plant distribution adminis., taxes, interest, depreciation	Net Profits
* 1940	33,532.29	1,925.60	6,006.89	991.62	30.00	386.77	372.75	9,713.63	26,452.01	7,080.28
1941	148,406.83	6,890.92	20,309.37	1,030.50	114.00	1,127.51	1,675.89	31,148.19	88,330.51	60,076.32
1942	148,123.61	9,151.49	20,747.44	1,051.11	120.00	1,461.41	1,932.11	34,463.56	91,711.30	56,412.31
1943	178,012.64	9,879.94	31,022.38	1,768.47	130.00	1,634.80	2,038.31	46,473.90	110,857.32	67,155.32
1944	224,184.97	12,478.20	52,045.67	2,643.83	120.00	2,326.99	1,991.53	71,606.22	137,130.17	87,054.80
1945	238,821.06	13,030.18	54,409.72	2,650.00	120.00	7,626.59	2,116.12	79,952.61	142,489.41	96,331.65
1946	231,822.22	15,774.28	45,300.36	2,683.39	140.00	5,722.26	2,309.00	71,929.29	140,428.73	91,393.49
1947	249,493.10	19,157.77	62,237.80	4,238.13	301.00	4,748.19	6,424.71	97,107.60	172,787.11	76,705.99
1948	268,491.08	20,093.88	95,928.83	4,831.26	120.00	4,495.92	8,201.90	133,671.79	208,097.16	47,512.78
1949	282,947.65	22,084.55	94,260.96	4,599.14	120.00	5,007.74	6,858.26	132,930.65	220,978.30	61,969.35
Totals	2,003,835.45	130,466.81	482,269.42	26,487.45	1,315.00	34,538.18	33,920.58	708,997.44	1,339,262.02	664,573.43

* 3 months

Entropy-Balance Diagram Spotlights Steam-Power-Plant Losses

By ALLEN KELLER

Assistant Division Engineer,
Turbine Engineering Division
General Electric Co.

Entropy-balance diagram shows how total entropy of the thermodynamic medium or fluid, in a power plant cycle, is increased whenever a cycle loss occurs . . . Heat-balance diagram, on the other hand, shows points in cycle where enthalpy is added, subtracted or transferred . . . By considering each entropy increase on a "per hour" basis instead of a "per pound" basis, heat rejection to condenser caused by each individual loss can be evaluated quickly and over-all effect of design changes observed . . . Article shows how entropy-balance diagram is derived, how each loss can be evaluated in terms of kilowatts

THE CONCEPT of a flow of entropy can, at times, be used advantageously to evaluate the different losses in a condensing steam power plant and to get quick answers as to the over-all effect of design changes.

What Is an Entropy-Balance Diagram?

When sensible heat is added to a quantity of matter, the change of entropy is given by the equation

$$dS' = dQ \div T \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For steam, water, or ice at any condition, the entropy may be obtained by making a proper integration of Equation (1) from saturated water at 32 F to steam, water, or ice at the condition specified.

If entropy per pound of fluid be multiplied by the fluid-mass flow, in pounds per hour, the product is the entropy flow per hour. An entropy-balance diagram is, then, a chart similar to a heat-balance diagram on which is represented the rate of flow of entropy throughout the entire steam cycle of a power plant.

There is, however, one important difference between a heat-balance diagram and an entropy-balance diagram. On the heat-balance diagram, the boiler, turbine, feedwater pumps, and condenser are the only places where heat (or more properly enthalpy) is added to or subtracted from the thermodynamic medium itself. At all other points in the cycle, enthalpy is only transferred, as from steam to water in a feedwater heater. On the other hand, on an entropy-balance diagram, the total entropy of the thermodynamic fluid is increased whenever a cycle loss takes place.

For example, consider an extraction steam pipe leading from the turbine to a feedwater heater. The pressure drop in this pipe will cause an increase in the entropy of the steam flowing in the pipe, and the hourly entropy increase taking place within the pipe will be a direct measure of the cycle output loss caused by the pipe fluid friction.

How to Construct an Entropy-Balance Diagram

Figure 1 is a conventional heat-balance diagram for a typical steam-turbine power plant having an 11,500-kw AIEE-ASME preferred standard turbine-generator set operating at rated load. On this diagram, the heat-radiation loss is assumed to be zero, and the power required to drive the hot-well pump and boiler feed pump is neglected. (If desired, feedwater pumping power can be taken into account without affecting the validity of the entropy balance as a means of evaluating losses.) The derivation of Fig. 1 is not described in this paper. The present data are abstracted from the paper, which was presented before the 1949 Annual ASME meeting, and will be published complete in the Transactions of the ASME.

Figure 2 is the entropy-balance diagram corresponding to Fig. 1. It it based upon the flows given on the heat-balance diagram. At each point on the diagram, the mass flow is multiplied by the specific entropy to get the entropy flow. Whenever the total entropy leaving a given piece of apparatus is greater than the total entropy entering the same apparatus, the difference between the two entropy flows is the entropy increase caused by the cycle loss taking place in the apparatus. For example, consider the steam-extraction pipe from the turbine to the No. 2 feedwater heater. The entropy flow at the pipe discharge is 9319.1 Btu/deg F/hr. This value was calculated by multiplying 5338 lb per hr flow by 1.7458 Btu/deg F/lb specific entropy (read from "Thermodynamic Properties of Steam," by J. H. Keenan and F. G. Keyes, John Wiley and Sons, New York, N. Y., 1936 edition).

At the pipe inlet the entropy flow is 5338 lb per hr × 1.7344 Btu/deg F/lb or 9258.2 Btu/deg F/hr. Therefore the 10 per cent pressure drop in this pipe causes an entropy increase of 60.9 Btu/deg F/hr.

Fig. 2 shows that 143,479.2 Btu/deg F/hr is the entropy rejection to the condenser circulating water. This value represents the sum of all entropy increases (ΔS) in Fig. 2. The largest single entropy increase is the 124,489.3 Btu/deg F/hr added by the

NOMENCLATURE

The following nomenclature is used in the paper:

- Q = mass flow, lb per hr
- H = enthalpy flow, 1000 Btu per hr
- p = pressure, psia
- q = sensible-heat flow, Btu per hr
- Q = sensible-heat, Btu
- s = specific entropy, Btu deg F/lb
- S = entropy flow, Btu deg F/hr
- S' = entropy, Btu deg F
- t = ordinary temperature, deg F
- T = absolute temperature, deg F
- v = specific volume, cu ft per lb

Table showing evaluation of individual losses of Fig. 1 heat balance

Item	(A) Entropy increase, Btu/deg F/hr	(B) Power loss, Kw	(C) Power loss, Per Cent of turbine power output	(D) Power loss, Per cent of boiler output
Drain cooler	48.3	7.8	0.065	0.022
Drain-cooler trap	2.6	0.4	0.003	0.001
No. 1 heater	702.5	113.5	0.951	0.323
No. 1 heater steam-extraction pipe	73.1	11.8	0.099	0.034
No. 2 heater	405.0	65.4	0.548	0.186
No. 2 heater steam-extraction pipe	60.9	9.8	0.082	0.028
No. 3 heater	275.2	44.5	0.373	0.127
No. 3 heater steam-extraction pipe	51.9	8.4	0.070	0.024
No. 3 heater trap	32.7	5.3	0.044	0.015
No. 4 heater	474.4	76.7	0.642	0.218
No. 4 heater steam-extraction pipe	80.7	13.0	0.109	0.037
No. 4 heater trap	26.9	4.4	0.037	0.012
Theoretical cycle losses	124489.3	20114.2	168.461	57.270
Turbine losses	16755.7	2707.3	22.674	7.708
Total losses	143479.2	23182.5	194.158	66.005
Turbine power output	*73898.3	11940.0	100.000	33.995
Boiler output	*217377.5	35122.5	294.158	100.000

* See text for an explanation of asterisked entries.

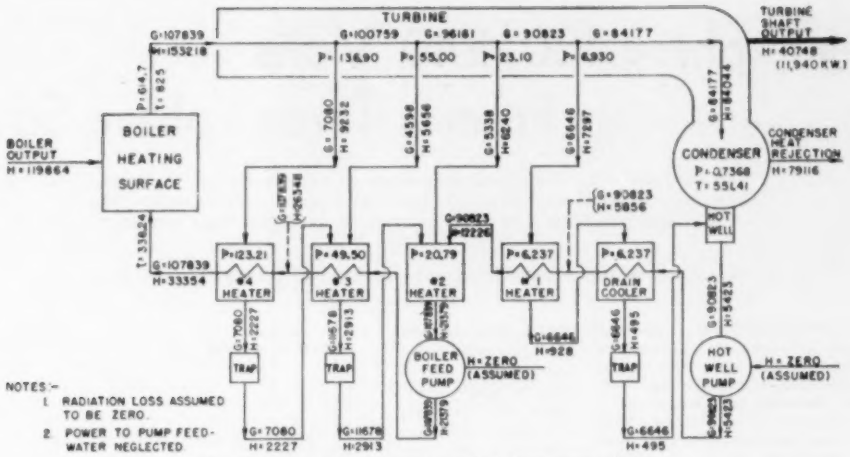


Fig. 1. Heat-balance diagram for typical steam power plant

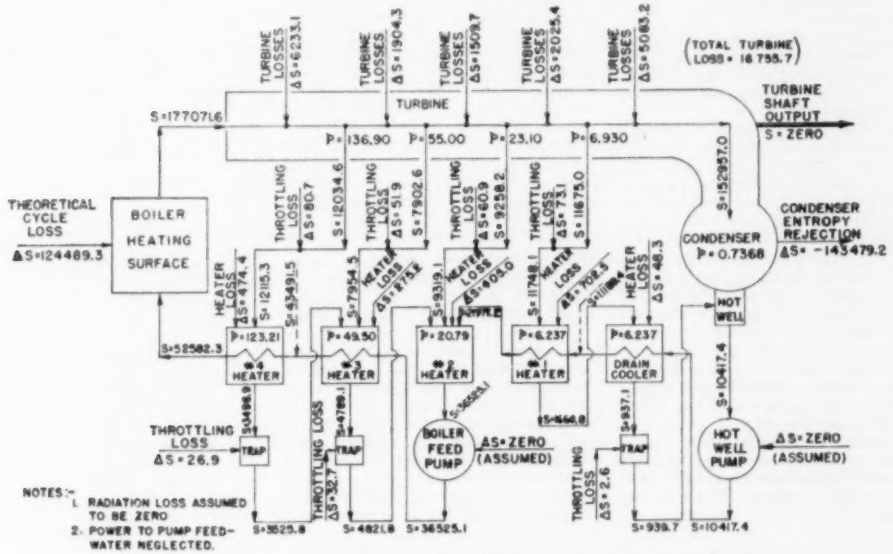


Fig. 2. Entropy-balance diagram developed from heat-balance diagram of Fig. 1

boiler. This quantity represents the theoretical cycle losses for the particular flow, boiler-inlet feedwater condition, and superheated steam-outlet condition shown in Fig. 1.

Evaluation of Losses

Substantially all condensing power plants operate with wet steam exhausts. For such plants, the turbine-exhaust-steam temperature is a function of the exhaust pressure only. Thus when Equation (1) is applied to the heat-transfer phenomenon in the condenser, the temperature T is a constant.

Figures 1 and 2 are based upon 1½ in. Hg abs exhaust pressure. At this pressure the saturation temperature of steam is 91.72 F or 551.41 F abs (T = t + 459.69).

With constant temperature, Equation (1) may be written in the form

$$\Delta q = T\Delta S \quad \ldots\ldots\ldots\ldots\ldots\ldots (1a)$$

Thus the condenser heat rejection corresponding to the 143,479.2 Btu/deg F/hr condenser entropy rejection in Fig. 2 must be

$$\Delta q = 551.41 \times 143{,}479.2$$
$$= 79{,}115{,}866 \text{ Btu per hr}$$

This value agrees with the condenser heat rejection calculated by heat-balance methods as shown in Fig. 1.

To illustrate the method of evaluating individual losses, consider again the steam-extraction pipe to the No. 2 heater. A previous calculation has shown the entropy increase in this pipe to be 60.9 Btu/deg F/hr. This entropy increase must be rejected at the condenser at 551.41 F abs temperature. The corresponding heat rejection at the condenser is

$$\Delta q = 551.41 \times 60.9$$
$$= 33{,}581 \text{ Btu per hr}$$

This is the heat equivalent of 9.85 kw. Thus the 10 per cent pressure drop from the turbine shell to the No. 2 feedwater heater is causing a power output loss of 9.85 kw or 0.0825 per cent of the 11,940-kw turbine shaft output.

Tabulation of All Losses

Table 1 isolates and evaluates each loss in the Fig. 1 heat-balance diagram, and Fig. 2 entropy-balance

(Continued on page 104)

Single-phase 120/240 Volts From a Three-phase Source

Modern load center unit substations provide an effective method for balancing large single-phase-loads on a three-phase power supply system. This article describes three very practical methods for using these substations

By **R. BRUCE JONES**, Industrial Power Division, General Electric Co., Schenectady, N. Y.

THE PROBLEM of obtaining large amounts of single-phase power from a 120/240-v system has always presented certain difficulties. Several methods for balancing a single-phase load on a three-phase supply are possible. In the past, either expensive banks of single-phase transformers or very expensive three-phase transformers have been used.

This article discusses three practical methods of balancing this single-phase load on a three-phase supply using modern load center unit substations.

The first method uses either two identical single-ended unit substations or a double-ended unit substation. The transformers are standard with 208Y/120 v secondaries and are each rated at one half of the expected load. The basic circuit for such a system is shown in Fig. 1.

The voltage between each of the six secondary leads and the neutral is 120 v. Two of the primary connections to one of the transformers have been reversed causing the voltage on that transformer to have a reverse phase rotation. Between opposite secondary leads we now have 240 v; i.e., 240 v between 1 and 4, 3 and 5, and 2 and 6 as shown in Fig. 1. The secondary neutrals are tied together and would generally be grounded to give a safer system. Whereas the diagram indicates connections to only one pair of secondary leads, single-phase loads are actually connected to all three pairs (1 and 4, 3 and 5, 2 and 6) of secondary leads.

This compact double-ended unit substation is particularly attractive from the standpoint of appearance, flexibility, cost and salvage value. Plant load can be taken from these unit substations if the test load does not require the full capacity. Care must be taken, however, not to overload one phase when applying both three-phase and single-phase loads. In the event the test load should disappear, these standard 208Y/120 v load center unit substations can be used to supply power to another part of the plant.

For economic and technical reasons the maximum practical size of a double-ended unit substation for this type of service is about 600 kva (i.e., two 300 kva transformers in parallel per substation).

The other two methods of balancing this single-phase load on a three-phase supply use only a single-ended unit substation. Three separately mounted autotransformers are used to supply both 120 and 240 v to the test area.

Using a standard unit substation with a 240-v delta secondary, the three autotransformers establish midtaps for the 120-v load, Fig. 2 (A). If the testing load is temporary and the plant has a 240-v system, this method is desirable. When there

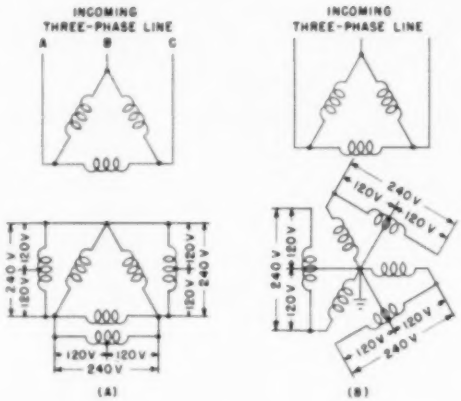


Fig. 2. These diagrams show how single ended unit substations can be used to supply single-phase loads by means of auxiliary transformers. (A) 240-v delta connected secondary. (B) 120-v wye secondary

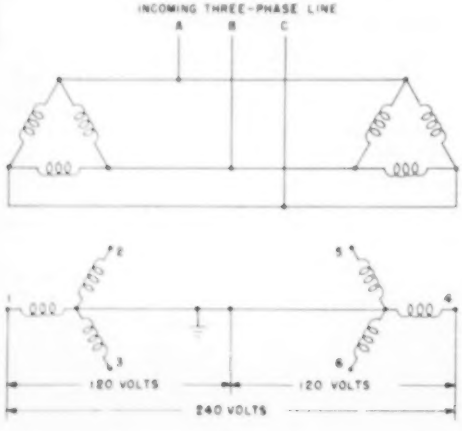


Fig. 1. Basic circuit to show how single-phase 120/240 v loads are connected to a three-phase double ended unit substation

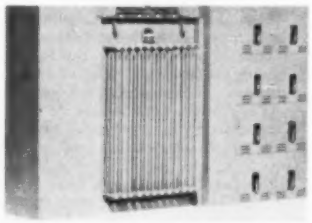


Fig. 3. Typical single-ended load center unit substation

is no further need for the 120/240-v single-phase power, the unit substation can be used to supply power to other parts of the plant. The chief disadvantage of this arrangement is that the midtaps of the autotransformers are at different voltage potentials and cannot be tied together or grounded.

If a standard unit substation with a 208Y/120-v secondary is used, as shown in Fig. 2 (B) the three autotransformers will be required to supply power to the 240-v load. For safety, the midtaps on the autotransformers are tied together and grounded.

These last two schemes (Fig. 2 (A) and (B)) may be employed where single-unit substations are preferred or where space is at a premium. However, it is necessary to use the separately mounted autotransformers to obtain the required test voltages. These auxiliary transformers increase the installed cost, losses and voltage regulation of the circuit compared with the first scheme, Fig. 1.

For each of these three schemes, it is necessary to divide the load into three equal parts and each part connected to a pair of secondary leads and the corresponding midpoint or neutral.

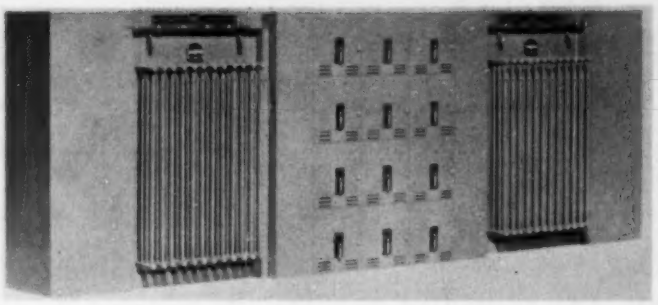


Fig. 4. Typical double ended load center unit substation

FILMING AMINES

(Continued from page 63)

a reduction of approximately 90 per cent in the corrosion rate was obtained.

The data contained in Table III are particularly interesting since the increased protection secured over a period of time is shown. As can be noted, the corrosion rate for Building No. 2 was not excessive even before treatment. The filming amine reached this point in the system quite quickly and promptly reduced the corrosion rate to a negligible value. Tests conducted 5 months later showed essentially the same results. The corrosion rate was so low as to be barely measureable.

Specimens exposed on the combined returns as delivered back to the boiler room showed a high corrosion rate prior to treatment. The steam and condensate systems at this plant are quite extensive and while an immediate improvement was noted on first applying the filming amines, the full effects of treatment are noted on the samples exposed 5 months later. Immediate results were secured at Building No. 2 since this point was close to the Power Plant. The combined returns specimens probably did not receive the full benefit of the filming amine treatment until all of the long lines acquired an amine film. Undoubtedly, also since the system was badly corroded some amine was adsorbed by iron oxide deposits until gradually all the surfaces became saturated. The 99-per cent reduction in corrosion shown by these data is quite impressive and is confirmed by plant maintenance records showing that pipe failures and replacements have been eliminated. The low corrosion rates on the combined returns were secured even with oxygen present in the condensate at this point due to air leakage.

A summary of data obtained from plants of varying operating characteristics is shown by Table IV. It will be noted that the protection secured ranged from 80-99 per cent. The corrosion rate is not directly proportional in each case to the carbon dioxide concentration of the steam due to factors such as flow rate, temperature, oxygen concentration, etc. which varied in each individual case. However, both before and after treatment the test specimens were exposed at the same point in the system and under the same operating conditions.

The development of the filming amines for corrosion inhibition in steam and return condensate line systems has added another useful method to those already available for application to this problem. The various methods of external treatment together with the neutralizing and filming amines for internal treatment furnish means for the efficient and economical solution of practically every type of steam and return line corrosion problem.

LETTERS TO THE EDITORS

(Continued from page 55)

needless waste. Actually, the unburned carbon emitted as smoke is less waste than has been claimed. Admittedly, it is an indication of poor combustion, but the greatest losses are elsewhere. Some claim the loss due to smoke is so small that it cannot be calculated with accuracy. Nevertheless it is an obnoxious pest that no one likes. At least we do not need it to signal our neighbor. We have better methods of communication.

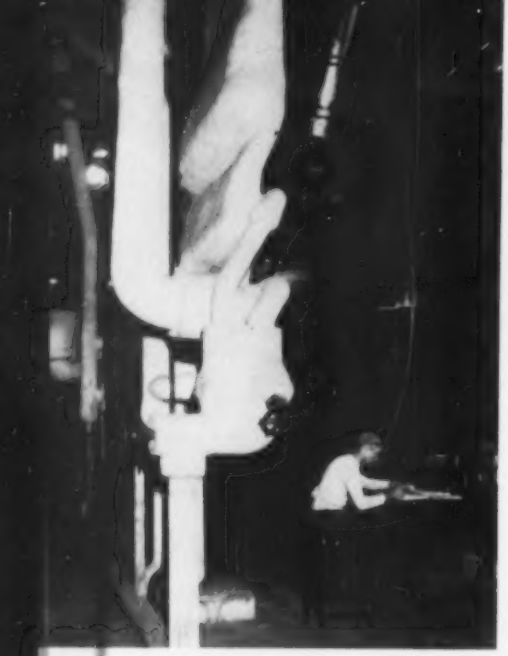
No two communities have identical problems, and no single cure-all can be prescribed. Location, terrain, and numerous other factors enter the picture. The direction of the prevailing winds, relative to the areas affected, must be considered. At some time or another an offensive emission from a stack is almost sure to occur. Zoning ordinances have long considered this and have prohibited the erection of industrial establishments where there could be cause for complaint.

Samples of air should be taken at regular periods, and throughout the community, to determine what has been accomplished. A periodic check to determine the soot fall should be made. Laboratory tests will be necessary to learn the results of the program. Air pollution control is a broad and far reaching movement. It can do a great deal to make our cities more desirable places in which to live. It can do a great deal to improve the general health of the community, and by the research entailed may enable us to reduce many hazards to health, some of which we have not dreamed of today. No one can, or dare, predict what the results will be be. Air pollution control is new, but it can meet with success only when the public accepts it whole-heartedly and gives it the support it deserves. At present it seems doubtful that any community, now striving to eliminate offensive conditions, will toss aside what is an accepted improvement.

To sum up, smoke abatement means a better, healthier, and cleaner place to live. It means additional pride in our community. It means more money in our pockets through savings in keeping ourselves, our homes, and all we have, cleaner and brighter. It means we will pass on to those who follow, an improved community and not a dreary, dingy, "down-at-heel" group of buildings we call our home town.

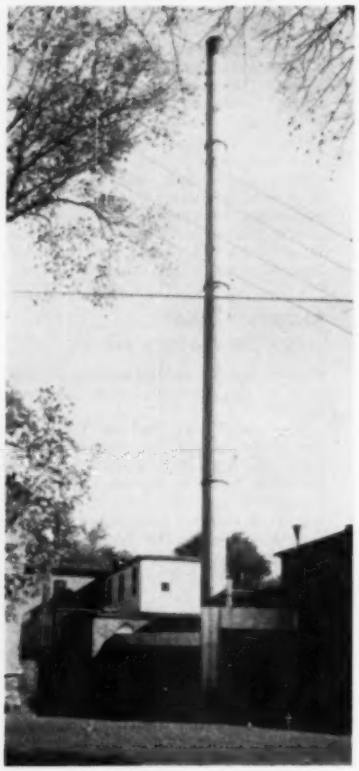
Ohio — L. K. HEROLD

Power Engineering



Left—At a chemical plant, a bank of high-temperature steam lines from waste heat boiler to overhead distributor drum was insulated as a unit, saving installation time, reducing cost, and requiring no special material. First, 1-in. thick mineral wool blankets with wire mesh backing on both sides were wrapped around bank, secured with ½-in. galvanized bands on 8-in. centers. Second, a ½-in. coating of mineral wool cement was troweled over blanketing.

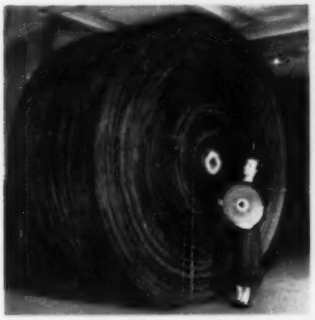
Three 3500-hp, 3600-rpm Allis-Chalmers boiler feed pump motors being prepared for shipment to a Midwestern utility. Believed to be largest 2-pole squirrel cage motors ever built; previous record for type was held by 2500-hp motors built in 1939



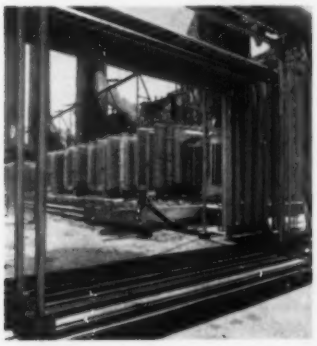
To replace a steel stack and combat corrosion, this wrought-iron smokestack, 42 in. in diameter and 120 ft high, has recently been installed by Contractor William Allen Sons Co. of Worcester, at the plant of A. H. Rice Co. at Pittsfield, Massachusetts

Model of Salem Harbor Station of New England Power Co., on which construction work has been carried on at Salem, Massachusetts since December 1948. Schedule calls for completion of first 75,000-kw unit in fall of 1951, second unit in fall of 1952. Erection of first boiler scheduled for late summer this year. Right-hand section of building faces ocean. Right to left—Circulating water pumps and intake screen; office, switchboard room; next, turbine generators; highest section, boilers; low section at left, F.D. and I.D. fans, dust collectors, locker rooms, machine shop. Plant being built by United Engineers & Constructors, Inc.; electrical installation and transmission lines by N. E. Power Service Co. Photo courtesy of *Contact*

NEWS REEL



Weighing more than 14 tons, this belt 1179 ft long was recently delivered by B. F. Goodrich Co. Diameter of roll, 10 ft, 2 in. Belt is Super Longlife Cord conveyor, 54-in. wide, 1/4-in. top cover and 1/16 in. back

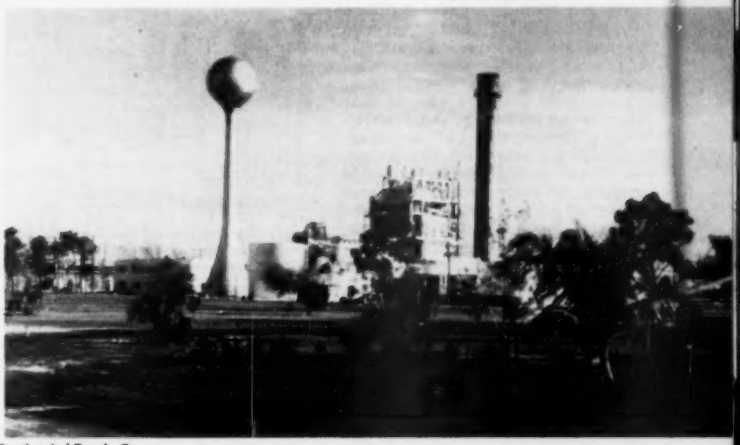


Framed by steam and fuel piping and electrical conduit are four of the thirteen 23,333-kva single-phase, 60-cycle GE transformers, 39.8/69 kv wye, 13.8 kv delta, at Redondo Beach Station of Southern California Edison Co.

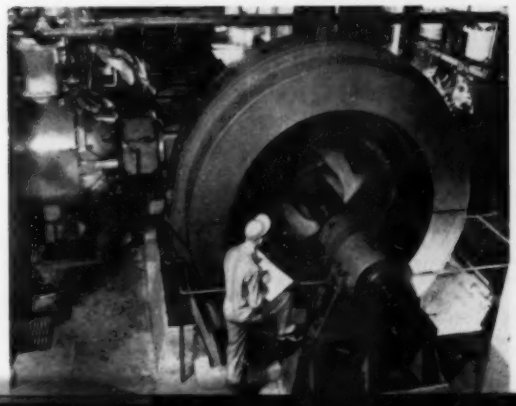
More power for Florida. Above—Sarasota plant of Florida Power and Light Co., built since war for 18,000-kw capacity, is being enlarged now by addition of 20,000-kw generating unit. Spherical water tank partly shown behind top right of stack. Below—The new Cutler Steam Electric Station of Florida Power and Light Co., capacity 80,000-kw. At left, 100,000-gal spherical water storage tank. The tropical setting is being carefully landscaped to give the entire station all possible eye appeal

The company has also just authorized construction of another new plant costing $6,000,000 to keep pace with the estimated expansion of its area. With its completion, the company will have increased its plant capacity 2½ times since V-J Day

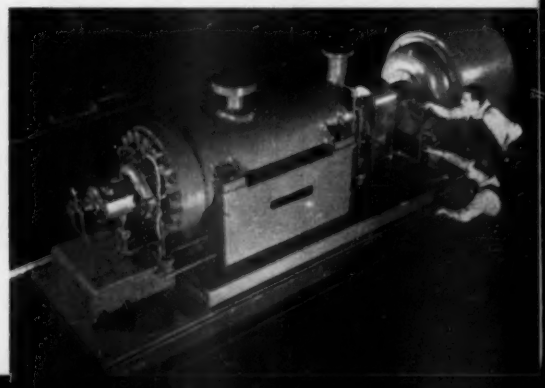
Photos from *Sunshine Service News*



Driving a Clark reciprocating compressor, for Portland (Ore.) Gas & Coke Co., this GE, 4500-hp, 300-rpm, 11,000-v synchronous motor is believed the largest to be used for such applications



This 5 by 5, Type BBJ, 12-stage Allis-Chalmers barrel-type boiler feed pump, rated 227,000 lb per hr at 1750 psig TDH, 243 F, 3575 rpm; driven by 800-hp motor



Gas-Turbine Electric Generating Unit Installed at Farmingdale, Maine

SECOND STATIONARY gas-turbine electric generating unit designed solely for the generation of electricity has just been installed* by Central Maine Power Co. at its Farmingdale Steam Plant, Farmingdale, Maine, a short distance from Augusta, Maine. This unit, a 3500-kw simple, open-cycle machine, designed for burning Bunker C fuel oil, is being prepared for regular operation at this writing. The unit was phased in for the first time on May 2, operating on Diesel oil, and for its first long test run it operated all night on May 18 burning Bunker C.

The 3500-kw unit at Farmingdale is of essentially the same design as the one installed at the Huey Station, previously described* in these pages, but there are two important differences. The first is that the Farmingdale gas turbine unit, at least for the present period, is in no way connected with the existing steam plant to utilize the waste heat from the gas turbine exhaust for increasing the efficiency of the steam cycle of the plant. Consideration was given to the installation of a regenerative-cycle unit but, because of its higher cost and the uncertainties of such a new type of central station generation, it was decided to install the simple but less efficient unit.

A second important difference is that the Farmingdale unit burns Bunker C fuel for normal operation, with Diesel oil for starting, whereas the Huey Station unit burns natural gas.

Details of 3500-kw Unit

The Farmingdale gas-turbine set is of the simplest possible design, consisting of a compressor, combustors, gas turbine, reduction gear, starting motor and generating equipment. The gas turbine is rated at 3500 kw at 6680 rpm, based on an outside ambient temperature of 80 F

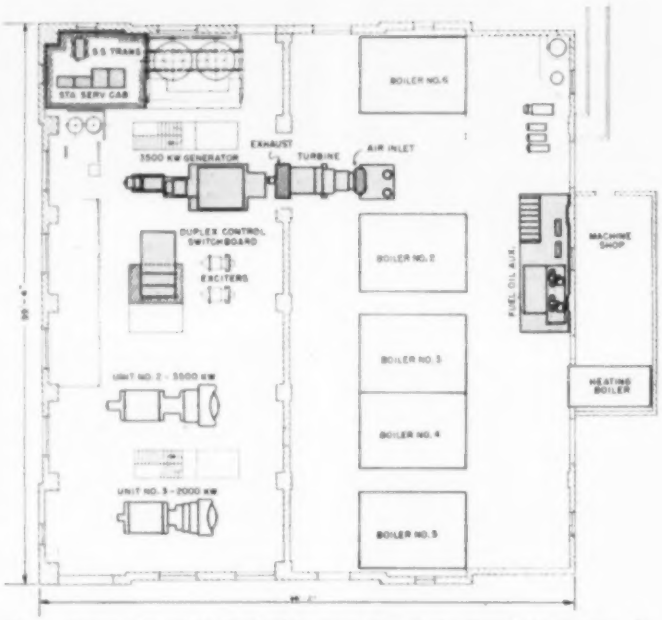


Fig. 1. General plan of the Farmingdale steam plant of the Central Maine Power Co., Farmingdale, Maine, showing how the new 3500-kw gas turbine generating unit was installed in space provided by removal of a 2000-kw steam turbine and a 509-hp boiler

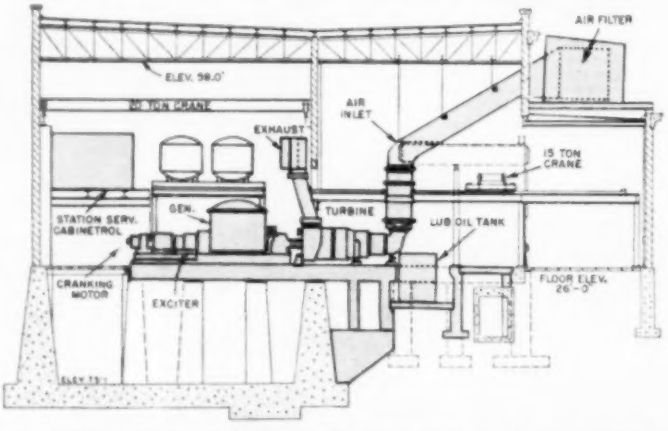


Fig. 2. Cross-section through the Farmingdale steam plant showing how the new 3500-kw gas turbine generating unit is installed on a slab mounted on existing foundations. Air intake for the gas turbine compressor is equipped with an air filter and exhaust duct passes out through side of building as shown in Fig. 3

*While the unit is the second gas turbine electric generating installation for strictly stationary service, it is actually the third stationary gas-turbine unit to be installed. The first was the 3500-kw gas turbine unit installed at the Huey Station of Oklahoma Gas & Electric Co., see POWER GENERATION, December 1949, page 54, and the second was the 2000-hp stationary gas turbine driving a gas booster or compressor on the Mississippi River Fuel Corporation's 22-in. pipeline connecting Monroe, La., with St. Louis, Missouri, see POWER GENERATION News Reel, September 1949, page 67.

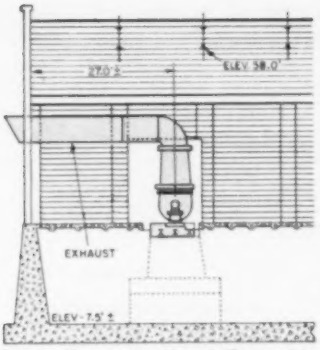


Fig. 3. Cross-section through Farmingdale gas turbine unit showing another view of the exhaust duct

and atmospheric pressure of 14.7 psia. The electric generator is rated at 4000 kw at 0.80 pf and 3600 rpm.

This open-cycle gas turbine is designed for inlet temperature of 1450 F and is direct connected to the 15-stage axial compressor operating at 6680 rpm. The compressor supplies air to six combustors of the standard tubular air-cooled type, details of which have been previously given in these pages. The general arrangement of turbine, combustors and compressor is the same as that of the Huey Station unit.

The turbine is designed for full load operation only, because the fuel requirements, even at no load, are in excess of 50 per cent of the requirements at full load. Expected over-all operating efficiency at full load should be in the vicinity of 17 per cent to the generator terminals or equivalent to approximately 8 kwhr per gallon of fuel oil.

Why A Gas Turbine? And Why at Farmingdale?

Farmingdale steam plant, a station of about 1912 vintage, was selected as the place for the installation of the first gas turbine on the Central Maine Power Co. system. To provide space for this new installation, one old, inefficient 2000-kw, 1800-rpm steam turbine was removed, as well as one 509 hp boiler. This left 5500 kw in steam capacity in the plant, including two steam turbines and five boilers. The general arrangement of the new gas turbine unit, with respect to the existing steam units, is clearly shown in Figs. 1 and 2, while Fig. 3 shows how the gas turbine exhaust duct passes out of the station.

Reasons for installing a gas turbine on the system of Central Maine Power Co. are twofold. First, the company is normally a hydro company; that is, it derives the bulk of its power from water and requires a certain amount of back-up power in the form of steam and internal combustion generating units. The new gas turbine unit, an internal combustion machine, was purchased with that idea in mind, because it is designed to make power available on short notice as, if, and when required for system make-up.

It is expected that full load can be attained from a cold start of the gas turbine in a matter of a few minutes, provided the fuel requirements are met.

The principal reason why the gas turbine generating unit was installed at Farmingdale was the availablity of housing and fuel oil storage facilities. A second reason for the installation of this type of equipment was that it is expected its operation will require a minimum of labor. In all probability not over two operators will be required per shift.

Another important feature of the new Farmingdale gas-turbine unit is that it is the first of its kind to employ Bunker C residual oil as fuel.

Automatic Controls for the Gas-Turbine Unit

Still another feature is that the starting and stopping of the turbine is carried out automatically and in proper sequence by a fully-automatic "self-starter" used for the first time on this unit. (See *Engineers' Preview*, POWER GENERATION, March 1950, page 8.)

The following functions will be automatically performed by the self-starter in properly timed sequence in starting:

1. Starter energizes turning gear to break away the unit.
2. Starts cranking motor to bring unit up to partial speed and actuate air compressor.
3. Opens fuel valve to supply Diesel starting oil to combustors.
4. Ignites fuel.
5. Allows unit to accelerate under its own power.
6. Transfers fuel supply from starting Diesel fuel to Bunker C for running.

After reaching normal speed, the unit is controlled by the operator in the same manner as a steam turbine, to synchronize the generator with the bus.

The stopping functions are automatically performed in the following sequence:

1. The fuel supply is transferred back to Diesel fuel to purge the fuel lines of Bunker C oil.
2. The fuel supply is gradually reduced till the flame goes out.
3. The unit coasts to a standstill.

While provision is made for testing of the individual steps, the starting and stopping sequence is always automatic.

Protective features are included to provide emergency shut down in case of abnormal temperatures, fuel and air pressures. All Bunker C oil is centrifuged and heated before being burned in the turbine.

Fuel Supply

The Farmingdale gas turbine is automatic, as described above, under the following limitations: The machine may be termed automatic only and after the fuel is made available at the throttle. The light Diesel fuel is made available from a pumping unit that is manually started. The Bunker C oil is made available only after it has been pumped from the heated underground tank through heaters to the centrifugers and from there to a 600-gal day tank. From the day tank, the oil is pumped through another heater to the turbine. All fuel oil pumps and centrifuges are manually started and stopped. After the throttle has the required fuel then the turbine may be brought up to full speed merely by the operation of a selector switch on the control panel. Full protection for all phases of temperature and pressures are incorporated in the automatic starting equipment. With the machine at full speed, the final step is to manually synchronize the generator on the line and build up the load.

Because this new unit at Farmingdale is the first of such units to operate in a central station power plant on Bunker C fuel oil and, at this writing, is not yet in full commercial operation, much of the procedure to be carried out by the operators is still to be definitely worked out. After the unit has been in operation for a while, much more can be and will be said, relative to the performance of the unit itself and the operating procedures.

With the installation and first successful testing of this second gas-turbine electric generating unit for stationary service at Farmingdale, Maine, the power industry thus takes another long step forward in bringing this new type of prime mover into full partnership with the others already in use.

Design and construction work and installation work on the new Farmingdale gas turbine unit were carried out by the engineers of Central Maine Power Co. and New England Power Service Co. in co-operation with those of the General Electric Co., which built the entire gas turbine generating unit and its accessories and auxiliaries.

GRAND COULEE DAM is now past the three-quarter mark in construction of its maximum power-producing potential.

Thirteen of an eventual 18 generators already are in operation, and with the placing of the outer shell for No. 14 recently, construction reached the three-quarter phase for over-all production.

Generator 14 will go into use later this summer, and generator 15 is expected to be completed before December 31, 1950. The final three generators, marking completion of the power plant, will be installed by the end of 1951.

Grand Coulee Dam started producing power nine years ago—on March 22, 1941—and already holds hourly, daily, weekly, monthly and yearly world's power production records.

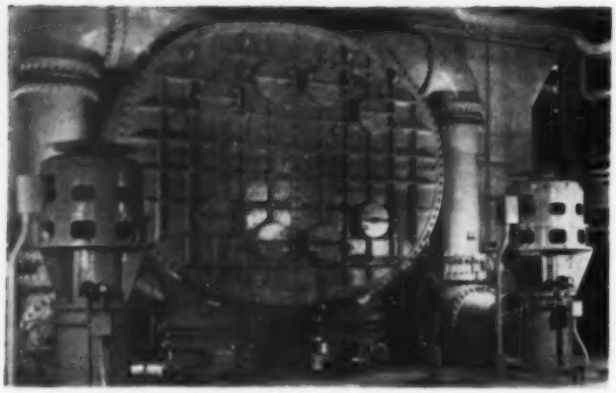


Fig. 1. View of two vertical circulating pumps, each powered by a 250-hp, 537-rpm motor, serving a surface condenser in a Midwestern power plant

By W. W. WELTMER
Hydraulic Engineer,
Centrifugal Pump Department,
Allis-Chalmers Mfg. Co.

Proper Suction Intakes Vital for Vertical Circulating Pumps

DURING the past decade, the column-type condenser circulating pump has become increasingly popular with power plant designers. One advantage of this type of pump is the ability to locate the pump's impeller below the water level in the suction intake. Another is that the positive head on the suction, and the relatively low discharge heads met in condenser circulating service, can be fully exploited through the use of pumps of comparatively high rotative speeds, namely the mixed flow and axial flow pumps.

Such pumps are an orderly evolution of the more familiar centrifugal pumps; but, because of their higher speed, they are more sensitive to departures from ideal flow conditions than the centrifugal pump. This increased sensitivity is especially pronounced when the flow irregularities occur on the suction side of the pump, thereby placing greater emphasis on suction intake design.

Our foremost villain is cavitation, which shows itself in physical damage to the pump's impeller, through pitting, and hydraulic damage to the pump's characteristic, through lowered efficiency.

Cavitation—Causes and Effects

Cavitation occurs when the net positive suction head, or NPSH, delivered to the pump's impeller is less than that required by that impeller. The pump manufacturer endeavors to choose or design a pump that requires less NPSH than his customer has available. The difference between the available and required NPSH is a safety factor. If the intake is of such design that its losses exceed its estimated losses by an amount greater than this safety factor, cavitation will occur.

But cavitation as encountered in the field usually is not as simple as that. It would be a general statement of the cavitation problem if we could depend on the available NPSH being uniformly distributed over the impeller's inlet area. However, if the geometry of the intake is such that some particular portion of the inlet area is starved, and if, in this starved area, the NPSH is less than that required by the impeller, then each vane as it passes through this low pressure area will cavitate. Thus we are not only concerned with getting the water to the pump suction with low loss, but we are also concerned with having the flow evenly distributed after we get it there.

Furthermore, low pressure elements of flow entering the impeller on one side carry through the impeller as relatively low pressure elements, while the higher pressure elements of flow entering the other side of the impeller carry through as relatively higher pressure elements. This pressure differential from one side of the impeller to the other imposes a radial thrust on the shaft and bearings. If pressure distribution is poor enough, the resulting radial thrust can cause mechanical troubles.

Pre-whirl

Another problem in the design of intakes is pre-whirl. If the geometry of the intake is such as to produce an organized whirling motion of the water entering, with the pump's axis as a center, the pump operating characteristics will be affected adversely. Pre-whirl having a direction of rotation counter to that of the pump will increase capacity for a given head and the attendant increase in horsepower can cause overheating of the motor. Pre-whirl having a direction of rotation

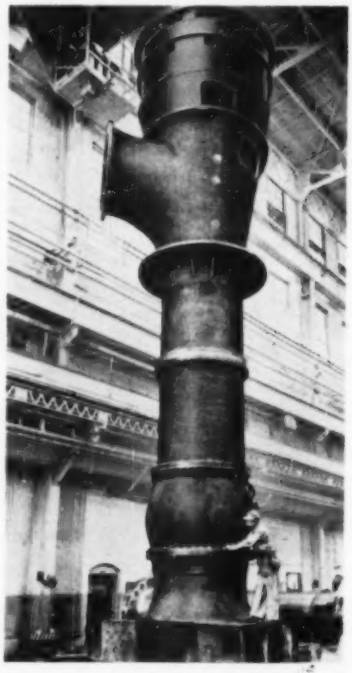


Fig. 2. Shop view of a 72-in. by 54-in. vertical circulating pump, capacity 76,000 gpm, 25 ft head, 270 rpm, 600 hp

Vertical or column type circulating pumps must be installed with correct suction intakes . . . Otherwise cavitation may result, and, if there is pre-whirl, it affects pump capacity . . . Poor distribution of inlet flow may cause mechanical rumbles and other troubles . . . How shape, dimensions, submergence, use of splitters, affect pump installed in suction bay . . . When using suction tube, velocities higher, special care needed in turning flow into pump, and vaned elbow solves problem satisfactorily . . . This explanation by one pump manufacturer will help you in checking existing vertical pump installations or planning new ones

the same as that of the pump will reduce capacity for a given head.

An allied problem is that of small violent vortices carrying air into the pump. This reduces the pump's capacity. This phenomenon is seldom observed if the mouth of the suction bell is sufficiently submerged below the surface of the water. Sufficient submergence for well designed intakes is three times the velocity head at the mouth of the suction bell plus one foot.

Two schools of thought are found in the design of suction intakes. One favors the suction bay and the other favors the suction tube. Both were discussed by the author before the 11th Midwest Power Conference. The distinction between the two may be seen by reviewing the familiar expression for head loss in a conduit, where the head lost is equal to an experimental coefficient depending on the geometry of the conduit times a velocity head based on some characteristic velocity in the conduit.

Suction Bay Intakes

In the suction bay type of intake, the velocity is kept low so that the value of the coefficient is relatively unimportant. Where the velocity cannot be kept low enough, we must resort to the suction tube design and every effort must be made to make the coefficient as low as possible through refinement in design. In both types, however, uniformity of distribution is of primary importance.

First, let's look at the suction bay type of intake. The type of pump we are putting into this suction bay is shown in Fig. 2. This is a rather typical example of mixed-flow, column type design. The discharge nozzle is 54 inches in diameter, and the mouth of the suction bell is 72 inches in diameter. The rating of this pump is 76,000 gpm, 25 ft head, at 270 rpm.

General Suction Bay Design

It is good practice to limit the distance from the mouth of the suction bell to the floor of the bay to not less than one-half of the bell's mouth diameter, and the velocity of approach in that section of the suction bay immediately upstream of the pump to approximately one-half of the velocity into the mouth of the bell. It is possible to satisfy this last restriction with suction bays having a section immediately upstream of the pump which is shallow and wide or deep and narrow. The suction bay of Fig. 3 is in the deep and narrow class.

The elevation of the bay shows that room has been provided at the back of the bay so that this portion of the suction bell may be fed by the upper elements of the flow in the bay. The sloping ceiling aids in this. The plan view of the bay shows its back wall to be heart-shaped, forming a splitter in the center of the wall. The purpose of this splitter is to prevent the formation of an organized pre-whirl in the suction bay.

Tests of Models of Vertical Circulating Pump and of Suction Bay

This pump of Fig. 2 was of such shape and size that we could not test it in our test pit. We therefore built a model pump to determine its hydraulic characteristics and a model of the suction bay to test it in. Provision was made to move the pump up and down and sideways with respect to the suction bay. Provision was also made for testing with and without the splitter in the back of the suction bay.

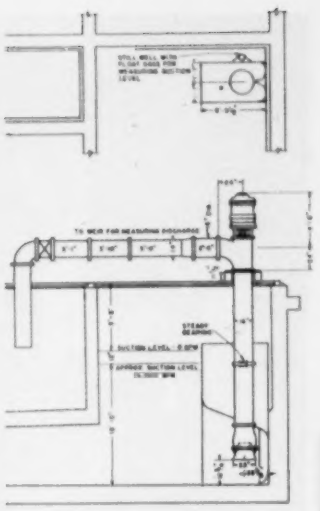


Fig. 3. This is a 23-in. by 16-in. model of the pump shown in Fig. 2, set up for testing in a model of a suction bay

To show the effect of an error in placement, comparative tests were run with the model mounted in the center of the suction bay, and displaced to one side so as to invite the formation of pre-whirl. Both tests were run without the splitter in the suction bay. The model was displaced to establish a pre-whirl of the same direction as the rotation of the pump. Theory said this would lower the head curve of the pump; the tests, Fig. 4, show this to be true.

A theoretical treatment of the

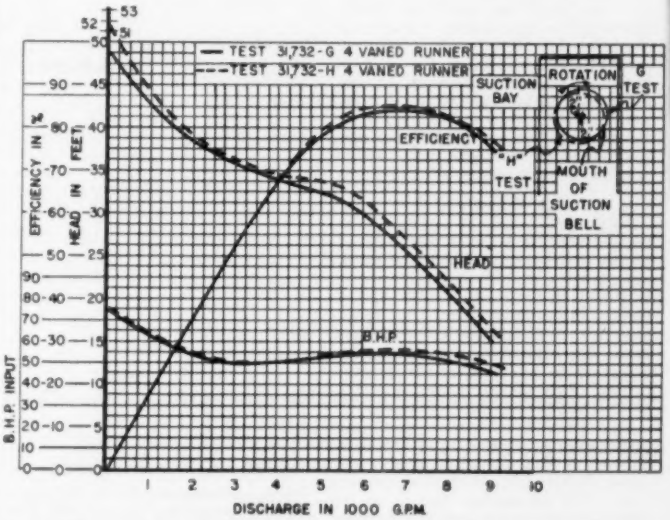


Fig. 4. Test curves from the model pump of Fig. 3, showing how pump operation and characteristics were affected by changing its position horizontally in suction bay

Fig. 5. Modern 38-in. by 24-in. mixed flow vertical condenser circulating water pump at Green Bay Station of Wisconsin Public Service Corp.

flow into a suction bell shows the height of the bell mouth above the floor to be one-half the diameter of the mouth of the suction bell. However, theory fails to give a tolerance for this dimension. Tests show that the height above the floor may vary between one-half and two-thirds the bell diameter with good results. The value of one-half the bell diameter should be taken as a definite lower limit.

In summary, for design of the suction bay type of intake, the distance from the mouth of the suction bell to the floor of the bay may vary from not less than one-half the mouth diameter to two-thirds the mouth diameter for best results. Velocity through the section of the suction bay immediately upstream of the pump should be approximately one-half the velocity into the mouth of the suction bell. In most instances, the velocity through this section will be in the neighborhood of 3 fps.

Design of Suction Tubes

Next, let's look at suction tube design. In the suction bay type of intake, it was noticed that the passages were spacious and the velocities low. In the suction tube type of design, the reverse is true: the passages are small and the velocities are high. The high velocities require the designer to exercise much greater control of the flow in order to obtain good distribution into the pump.

An axial-flow type circulating pump and its suction tube intake is shown in Fig. 6. This pump was rated 20,000 gpm, 18 ft head, at 875 rpm. The discharge nozzle is 24 inches in diameter and the suction bell is 30 inches in diameter. The intake of Fig. 6 might be termed a betwixt-and-between design. Its geometry is that of a suction bay, while the velocities in it are in the suction tube class.

Tests of this pump alone, without the intake, showed it to be a smooth-operating, satisfactory pump in every respect.

When tested with the intake shown in Fig. 6, however, the pump displayed violent periodic rumbling. The period of these rumbles was from 10 to 12 sec. During the lulls between rumbles, operation was smooth. In order to determine the cause of this rumbling, we placed pressure openings around the periphery of the suction bell and observed the behavior of these pressures during operation. During periods of lull between rumbles, these pressures were sensibly constant and stable, but as a rumble started and built up to a climax, the pressures at the upstream edge of the suction bell dropped lower and lower until they dropped out of sight at the climax of the rumble. Such a pressure distribution could only affect the pump adversely, both hydraulically and mechanically.

Having identified the problem as one of distribution, we built the suction elbow shown in Fig. 7, called a vaned elbow and known to have excellent distribution characteristics as well as low losses. The losses in such an elbow are from 20 to 25 per cent of the velocity head based on the velocity through the elbow. Tests of this pump with this intake were very gratifying—smooth, stable operation, and high efficiency.

To summarize: The velocities in the suction tube should be held in the neighborhood of 6 fps. We might go to 8 fps in some instances. Special care must be exercised in turning the flow into the pump. The distribution of flow into the pump is a prime consideration. The vaned elbow offers a satisfactory solution to this problem.

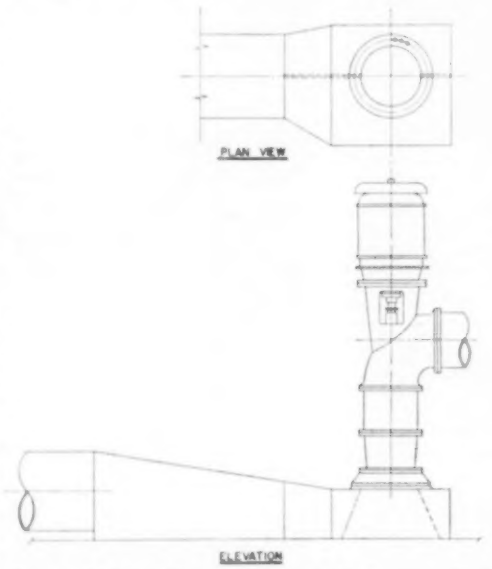


Fig. 6. Original setting of 20,000-gpm, 18 ft head, 875-rpm pump, 24-in. discharge, 30-in. suction bell diameter, showing setting with suction tube that caused mechanical rumbling

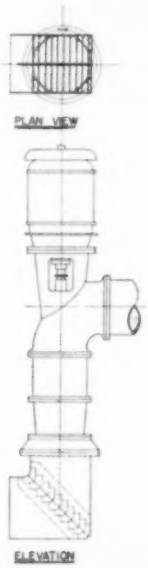


Fig. 7. How suction tube of pump of Fig. 6 was arranged with vaned elbow, giving smooth, rumble-free, satisfactory operation

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

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FLUORESCEIN

How many of you have struggled with the job of finding leaks in your surface condenser when you found your feedwater becoming contaminated? Those of you who have know that it's not an easy job. You could do it in several ways; you could create a vacuum on either the vapor or cooling water side of the condenser and listen for the whistle of air leaks, or you could fill the vapor space with water and check the tube plates for leaks. With leaks that are large enough these methods work fairly well but they fail when the leaks are very small. And many small leaks are just as bad as a few large ones.

If you have been up against this sort of trouble, listen then to a new way of finding these small leaks found by a British chemist, C. Wood, at the Early Power Station in England. Described in a recent issue of Detroit Edison's "Coal to Kilowatts," this new method consists of filling the condenser vapor space with water and adding to the water one part per million (one ounce per 30 tons of water) of ***Fluorescein***. Fluorescein is a dyestuff which gives off a bright green glow when exposed to ultra-violet rays. A mercury vapor discharge lamp is used as a source of ultra-violet. It is easy to pick out the leaking tubes with the lamp in semi-darkness. Even if the leak is only a drop it shows up brightly. Other fluorescent materials such as fish scales, oil, river debris, do not cause confusion because these materials give off a pale blue white glow under ultra-violet rays much different from the brilliant green of the fluorescein.

First use of the fluorescein method was made by the Detroit Edison Co. on March 31, 1950, at the Trenton Channel Plant. The results were very good, many small leaks being detected that could not have been found otherwise.

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Common Phenomena Are Not Simple

Don't be misled by the apparent simplicity of simple things. Basically most simple phenomena are complex and in order to deal with them one needs a good grounding in the basic sciences. In this article are presented several examples showing the truth of Dr. Langmuir's famous statement, "Common phenomena are not simple and simple phenomena are not common"

By ANDREW W. KRAMER

COMMON PHENOMENA, says Dr. Irving Langmuir, are not simple, and conversely, simple phenomena are not common.

Not long ago, one of my business associates told me about trouble he was having with an outdoor lamp in front of his home in the Chicago suburbs. This lamp, mounted in a lantern on a post, burned out frequently, though it was lighted only a few hours each evening. Not knowing much about electrical matters he asked me if it could be due to a *short* in the circuit. Of course, I told him that, that could not be the trouble since if it was a short, the circuit fuse would blow, not the lamp. I suggested that the circuit voltage might be too high for the lamps he was using but found that the lamps were correctly rated. Yet, they burned out in a matter of several weeks—they became very black.

When I was apprised of the latter fact, that the lamps became very black, I began to suspect the real cause of the trouble. I asked my friend to bring one of the burned-out lamps down. As he had explained, when I examined the lamp, I found it very much blackened, much more so than a lamp which fails in ordinary service.

It was at this point that I remembered Dr. Langmuir's work. Examining the bulb more closely this time with a strong magnifying glass, I found a tiny crack at the top of the bulb, a crack so fine that it was scarcely visible. This, of course, immediately explained the trouble. Quite obviously, the lamp housing leaked and in bad weather, when it rained or snowed, cold water dripping on the hot bulb cracked it, admitting air and water vapor.

But why should the bulbs become so black, asked my friend? This, I told him, was not so simple to explain but there was an explanation, one given by Dr. Langmuir himself.

In his early work in improving the incandescent lamp, Langmuir had found that when he introduced various gases in lamp bulbs, the only one which produced serious blackening was water vapor. Hydrogen, oxygen, nitrogen, carbon monoxide, etc., did not produce blackening but when he introduced even a very small amount of water vapor, severe blackening resulted.

Why the bulbs blacken

This blackening depended upon a cyclic reaction in which *atomic* hydrogen played an essential part. The water vapor molecules coming in contact with the hot tungsten filament produce a volatile oxide of tungsten, and the hydrogen is liberated in atomic form.[1] The volatile oxide deposits on the bulb where it is reduced to the metallic state by the atomic hydrogen, while the water vapor produced returns to the filament and causes the action to be repeated indefinitely. Thus, a minute quantity of water vapor may cause a relatively enormous amount of tungsten to be carried to the walls of the bulb.

His lamps burned out

It is obvious then that while the failure of the lamps was due to simple cracking of the bulbs by the sudden incidence of cold water the explanation of the blackening of the bulbs is a complex matter involving a basic understanding of chemistry and physics.

It may not always be apparent but many of the problems the practical power plant engineer is concerned with depend upon basic understanding of physics and chemistry. In combustion, in heat transmission in boilers, heaters, condensers and evaporators, in the use of measuring instruments, in refrigeration, air conditioning, in the chemistry of water and oils, in the protection of surfaces, in the operation of engines, pumps, turbines, fans, in the flow of fluids through pipe lines and ducts, in the generation, transmission and use of electrical energy, in all these things the practical engineer's effectiveness depends to a large extent upon how well he understands the basic physical, chemi-

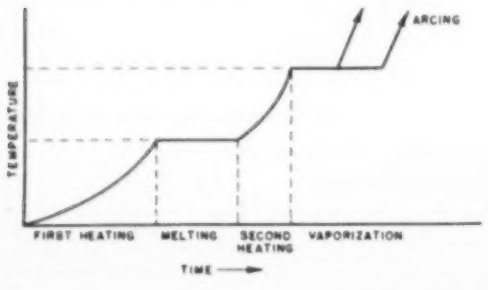


Fig. 1. Curve showing action of fuse in blowing

[1] Ordinary hydrogen consists of molecules of two atoms each. At very high temperatures, these molecules are dissociated and split into separate atoms. When in this state, it is known as atomic hydrogen. This is the type of hydrogen involved in the atomic hydrogen welding process developed by Dr. Langmuir.

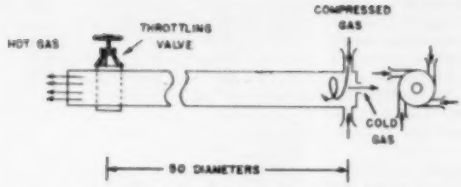


Fig. 2. The Counterflow type of Hilsch Tube

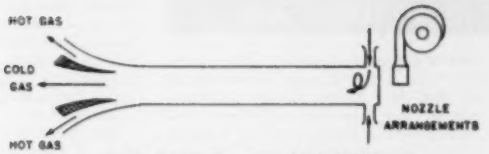


Fig. 3. The Uniflow type of Hilsch Tube

cal and mathematical principles upon which all of these branches of his work are founded.

Of course, probably the most valuable attribute of the good practical engineer is common sense. Unless he has this, all his profound knowledge of physics and chemistry is of little avail. Yet, as pointed out in the May issue[2] his common sense, his ability to form judgments quickly and accurately is due many times to his unconscious application of basic principles of physical phenomena.

Consider the blowing of a fuse for example. This, obviously, seems a simple thing. A fuse is nothing but a weak link in an electrical circuit and when the current becomes too great it heats and *blows*. But suppose we are interested in the more fundamental aspects of the blowing of a fuse, what can we say about it? Suppose we approach it as Dr. Rudenberg does in his famous book "Transient Performance of Electric Power Systems," then, what do we find? We find something like that shown in Fig. 1 which is a curve showing what happens when a fuse blows. At first, the fuse merely heats. Then when the melting point of the metal is reached, energy is still put into the fuse but the temperature does not rise. This is latent heat of liquifaction. Then, when all the metal is in the molten state, a second temperature rise occurs, until the state of vaporization is reached. Then, again, there is a period during which energy is added without raising the temperature. This is the latent heat of vaporization. Finally when all the metal is vaporized, there is a further rise in temperature as the various substances are vaporized. In all this time the effects of gravity can be neglected since the entire period is so short that the forces of gravity do not have time to act. Finally when the vapor state is reached and the molecules begin to separate, at some stage of the process an arc is formed and the electrical conduction passes from the solid to the gaseous state. At this point, the effect of ionization begins to act and if we pursue the subject further we get into the whole vast theory of arc phenomena. So if you want to know all about fuses, you really need a good knowledge of physics and thermodynamics.

Many absurdly simple things are more involved than they may seem at first. As an example, as many of you who read these pages regularly may remember, several months ago, a reader wrote us and asked a simple question, at least it seemed simple until we started to think about it. The question was, "How do you test a ladder?"

How Do You Test a Ladder?

Our first reaction to this question was one of mild astonishment. Why should anyone ask such an absurdly simple question? A few moments serious consideration, however, made it clear that the question was far from simple. A load test of a ladder is probably more dangerous than no test at all, since there is more probability of weakening a good ladder than there is of finding defects in a weak ladder. As will be recalled this apparently simple question started a three page discussion most of which was to the effect that you DON'T test ladders. There is more to it than that, however, and the discussion of this subject in the February (1950) issue should be of interest and value to all practical engineers. Among other things we learned about ladders is that they should never be painted.

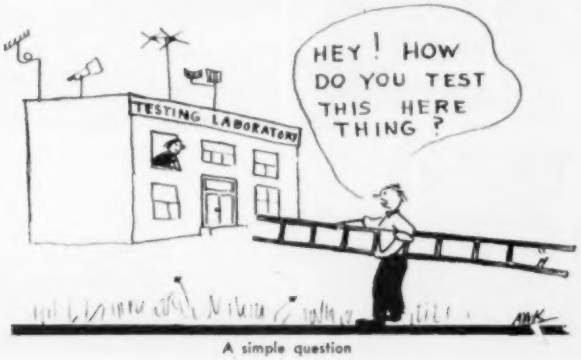
There are many such questions which we may take for granted until we have to do something about them and then we find that they are not as simple as we assumed them to be. Here is another one, one that appears in this issue's Question and Answers section—How do you test an electrical ground? It will be interesting to learn what this question brings out.

The Hilsch Tube

Last month, in the Engineers' Preview, we referred briefly to the Hilsch Vortex Tube. Here is another illustration of Dr. Langmuir's remark about simple phenomena. The Hilsch tube is simply a tube supplied at the center with tangentially moving compressed air and exhausting cold air at one end and hot air at the other. Actually, this device was discovered by Georges Joseph Ranque and first patented in France in 1932. In his patent, Ranque shows two basic types of design which may be called counterflow and uniflow, illustrated in Figs. 2 and 3. What could be simpler? Nothing but a straight piece of pipe, yet when supplied with air at 105 psi and 70 F, under certain conditions, the warm air issued from the tube at 30 F while at the same time, the cold air issued at a temperature of -50 F.

The explanation of this action is rather difficult. Ranque presented a theory of its operation in his first patent but later, he rejected this in favor of quite a different one. At the present time, the theory for both the uniflow and counterflow types may be summarized as follows: Fresh gas, before it has travelled very far in the tube, succeeds in forming an almost free vortex in which the angular velocity is low at the periphery and very high toward the center. But friction between the laters of gas undertakes to reduce all the gas to the same angular velocity, as in the solid body. This

[2] The Practical Engineer—Who Is He? Page 74.



A simple question

causes the inner layers to slow down and the outer layers to speed up as the gas moves along, amounting to the flow of work from the center to the outside of the vortex. At the same time, because the center of the vortex is much colder than the outside, heat flows toward the center, but not so rapidly as the work flows. The inner gas is originally cooled by its expansion; it stays partly cold by giving away its kinetic energy to the outer gas by friction without receiving as much heat energy in return. The outer gas in turn receives more kinetic energy than it loses heat energy, and this kinetic energy eventually becomes converted into internal energy through friction in the hot end of the tube. The flow is highly turbulent and the free vortex is supersonic.

This is a very simple explanation. Actually, what is needed to thoroughly understand the action of this tube, is a profound knowledge of aerodynamics, hydraulics coupled with considerable skill in applying mathematics. At the present time, the Hilsch tube is the subject of great interest on the part of scientists and engineers all over the world and it still remains to be shown just what practical use it will have. If efficiency is not too important, it presents one of the simplest methods of obtaining refrigerating effect at our disposal. For refrigeration in minute quantities or for very occasional use where stored compressed air is available, it is suitable. It is a remarkable invention. Those interested in a really comprehensive study and analysis of the Hilsch tube, an article in the May issue of *Refrigerating Engineering* is highly recommended. We mention it here because we feel that it is a development all practical engineers should know something about.

How An Ailing Refrigerating System Was Restored to Good Health

By GEORGE HOLMAN
Decatur, Illinois

A REFRIGERATION system is a closed, hollow circuit ordinarily impervious to the unintentional entrance of materials not wanted in it. In most large systems, moreover, ammonia as the refrigerant circulates much of the time, often turbulently. It would appear that the physical and chemical action of this strongly alkaline fluid would suffice to keep the inner parts of the system clean and free of obstructions.

That ammonia circulation does not keep a system clean and free of foreign matter is a well-known fact to every operating engineer, maintenance mechanic or service man of refrigeration plants. In every system there is always a more or less gradual accumulation of substances inert to the chemical action of ammonia, and of such consistency that deposits form, even in areas of turbulent flow. Restrictions form, and at critical points the flow of refrigerant, whether vapor or liquid, may be completely stopped.

The nature and source of these deposits are usually known, or may be readily determined. Substances and sources may be classified as follows:

1. Oil used as the compressor lubricant which has been carried over into other parts of the system.

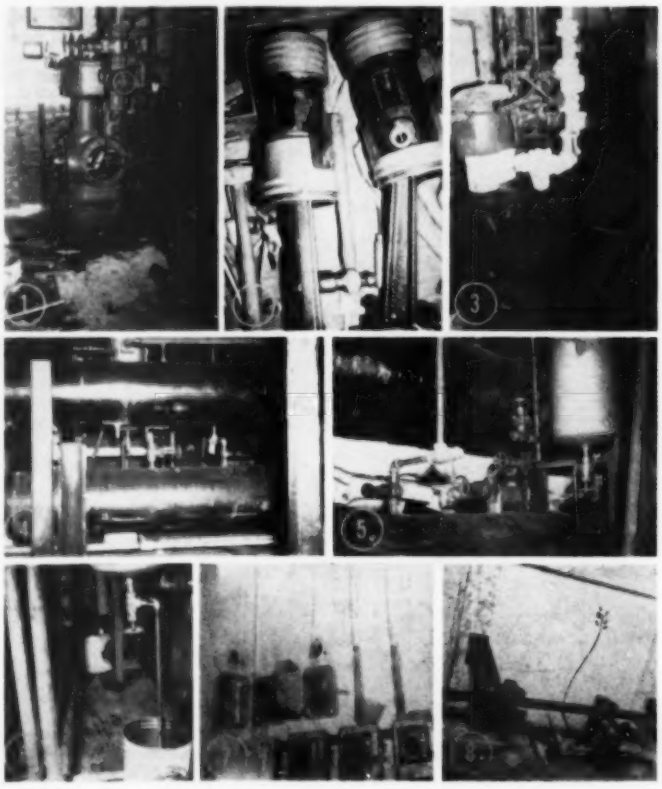


Fig. 1. This 6 by 6 in. compressor was ruined by ball bearings from manifold valves. These small balls were found at several locations. Fig. 2. Pistons scored by various solid materials, including valve bearings from manifold. Fig. 3. Pronounced flooding back of liquid ammonia into the cylinders of the 5 by 5 compressor. Fig. 4. Shell and tube condenser and liquid receiver. Liquid gauge glass, showing 3" of oil, at start of servicing, is behind shield. Fig. 5. Receiver trim showing condenser, receiver, safety valves and oil trap. Fig. 6. Into these two buckets more than 40 gallons of carryover oil was blown down from the oil trap, condenser and liquid receiver. Fig. 7. Time switches A and B. A controlled the solenoid stop valve which shut off the liquid of two beef room evaporators. B controlled the solenoid valve which shut off the liquid of four chill room evaporators. Simultaneous shutting off of six evaporators caused sudden and serious suction pressure drop. Fig. 8. Solenoid operated liquid stop valve in beef room. From this point in the system the writer drew off more than a gallon of carryover oil

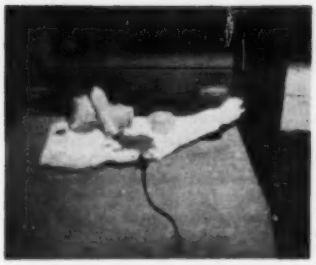


Fig. 9. Scale trap protecting solenoid stop valve. Each of these traps was filled with a coal-like substance

2. The scale derived from the inner surfaces of pipes and vessels of which the system is composed.
3. Excess litharge used on pipe threads during system assembly.
4. Metal clippings which have been left in pipe ends after threading operations.
5. Products of erosion, due to cutting action of other solid impurities entrained in the circulating refrigerant.
6. Foreign materials left inside pipes, valves, vessels or machines during assembly of the system.
7. Products of corrosion usually negligible in ammonia systems.
8. Metal worn from compressor bearings, cylinder walls, etc.
9. Parts of wicks of lubricators, pieces of packing, etc.
10. Products derived from the breakdown of lubricating oil.
11. Emulsifications formed with oil and water, with or without other substances.
12. Working parts of the system, such as lead disks of valves, pieces of babbit from bearings, etc.

The deposition of solid or semi-solid substances in a refrigeration system may occur at any place. Usually, however, depositions occur in line strainers, oil traps, condensers and other large volume vessels. I have found sludge $\frac{1}{8}$ in. thick lining the walls of enclosed compressor crankcases. In many cases these deposits did not dissolve in new oil, even under the splash action of the cranks during compressor operation.

Deposits basically due to the emulsification of oil and water dissolve easily in cleaning fluids, gasoline, carbon tet, etc. Often they dissolve without treatment, and without residue. Such deposits are troublesome in very small quantities, since they may destroy the effective control of thermoexpansion valves.

Firm solids, such as scale, are found in strainers installed in the systems for the purpose of separating them from the circulating ammonia. They are also found in such vessels as the liquid receiver, condenser, accumulator, etc. These larger vessels are provided with blowdown valves for the purpose of removing sludge and oil. To remove these substances from the smaller traps of solenoid stop valves, thermoexpansion valves, and the suction line strainers of compressors, however, it is necessary in most cases to remove cover plates. This makes necessary the pumping down of the system, at least that part of it which must be opened.

How often an extensive refrigeration system should be cleaned ought not be a debatable question. In my opinion, oil blowdown valves should be tried for oil and sludge at least once weekly, and the total quantity of oil drawn from them compared with the quantity of oil charged into the compressor. They should closely balance. A once-a-month look into the compressor may determine the extent of oil breakdown, while all traps, strainers and important system parts should be looked into at least once yearly. After a routine off-season cleaning and repair, a refrigeration system may be depended upon to give troublefree service throughout the running season.

In points of poor system design, deterioration, ill repair and heavy impurity accumulations inside the circuit of the refrigerant, the refrigeration system shown in part in the illustrations is the worst I ever came across. For several months this system stood in need of service which, due to the inability of the area's only ammonia service team to get around to it, it failed to get.

The largest of two compressors, a 6 by 6 in. Frick, had begun to pump oil badly. By October 1, 1948, a charge of oil remained in sight in the compressor crankcase gage glass less than four hours. One man had a daily assignment to blow down this carry-over oil from the oil trap. Added to this trouble were many others, chief among them being the general misbehavior of several thermoexpansion valves. Refrigeration was poor in the cold rooms, and flooding back of liquid into the compressors was almost continuous.

The pressing need for service brought me the assignment to restore the system to working order. While oil was being blown out of the oil trap and liquid receiver, the

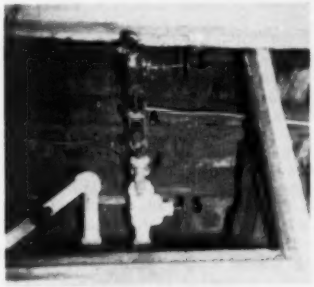


Fig. 10. Solenoid stop valve and thermoexpansion valve which were installed in place of an old hand expansion valve on old style evaporator. This made the system almost fully automatic

6 by 6 in. compressor was dismantled to determine the cause of the oil pumping. The pistons were removed from the cylinders, and found to be badly scored (Fig. 2). In spite of the frequent changing of new oil, some sludge was found inside the compressor crankcase. In this sludge, in the crankcase pumpout line and on the web between the cylinders, several quarter-inch ball bearings were found. These had come out of a stop valve of the manifold. Grooves scored by these balls were found in the cylinder walls of the compressor (Fig. 1).

A new column with pistons and a new crankshaft were ordered. While awaiting delivery, restoration of the system to efficient operation with the 5 by 5 in. compressor became urgent, due to the smaller capacity of this unit. Although this compressor did not pump oil, liquid from the flooding evaporators carried over into the compressor crankcase to mix with the lubricating oil (Fig. 3). Besides the liquid, there was a continuous return of oil from the oil-logged system. This oil accumulated in the crankcase. With each attempt to remove this oil by first evaporating the liquid in a pumped-out crankcase, the compressor pounded heavily. Oil and ammonia together had to be blown out of the crankcase into a bucket partly filled with water.

In spite of the need for refrigeration, a pumpdown was deemed necessary. Since 11 of the 12 evaporators had forced air circulation, and 10 of the 12 had small volume, the pumpdown was carried out within 3 hr. Less time would have been required, but for the efficiency loss caused by the liquid flooding back, and by the compressor slugging oil from low spots in a rather intricate return vapor line.

In all cases of flooding, a pumpdown enables the compressor to regain control of the system, if only for a short time. After the master valve is closed, liquid flooding any evaporator ceases to be carried out into the return line, and that in the return line either evaporates or is carried on into the compressor, or an accumulator. As during any period of flooding, liquid entering the compressor cylinders evaporates, and by filling the cylinders with vapor prevents, or partly prevents, the entrance of vapor from the return line. This detracts appreciably from compressor capacity. Pumping down a flooded system so designed that liquid can enter the compressor by gravity, is always a slow procedure.

As soon as the discharge line showed superheat, all thermoexpansion valves were set up as far as the stems could be turned inward. This attempt proved futile, however. For within 30 min after the master valve was opened, the frost line moved back to the compressor cylinders.

Examination by eye and stick test

showed that setting up the thermal valves had stopped some from admitting liquid, but had no effect upon the flooding by others. In fact, the complete shutting off of a part of the valves lowered the suction pressure, and left only the flooding evaporators in operation. This condition was further aggravated by the time switches (Fig. 7). As each shut off its battery of two and four evaporators, respectively, the rapid pressure drop caused the flooding to become more and more pronounced. The compressor slugged oil so badly that the time switches were temporarily short-circuited by jumpers.

A slow oil blowdown from the crankcase through the oil charging hose into a partly-filled bucket of water was commenced. Although the crankcase held a maximum of 4 gal of oil, 10 gal were blown out during two working days of 8 hr each. At the end of this time more than 40 gal of oil had been blown down from the oil trap, condenser and receiver, and the quantity of oil working back to the compressor gradually diminished. In this system the compressors were not protected by accumulators.

Although this was a small packing plant, there was a steady kill of hogs and beeves through five days weekly. To stop the flooding, yet maintain satisfactory refrigeration of this load of meat with an undersize compressor presented quite a problem. The three rooms which received the load were on the ground floor, each kill passing first to a chill room, thence to a temporary holding room and thence to a cutting room. 10,000 to 30,000 lb of beef and pork had to be reduced to cutting temperature each day.

Each of four basement rooms had a separate evaporator fed by a thermoexpansion valve and shut off by a thermostat which opened and closed a solenoid stop valve. All evaporator outlets connected into a common vertical vapor line which led upward to the second floor. There it joined three other vapor lines, one from each of the three first floor rooms. Junction was in a manifold sealed in concrete. From this point the main return line passed out through the wall of the second story, and led down into a building addition which housed the compressors.

There was no record of the line scale traps having been cleaned. When the master valve was opened after the first pumpdown, frost appeared at a solenoid stop valve instead of at the expansion valve further downstream. This indicated a restriction, and expansion of ammonia through it.

This and four other scale traps of the system's five solenoid stop valves were cleaned one by one. Each was filled with a coal-like substance (Fig. 9) saturated with oil. At one of these solenoid stop valves (Fig. 8) more than a gallon of oil drained out as the line was opened.

After the solenoid stop valves had been placed in working order, and the quantity of oil in the condenser, receiver and liquid line reduced to a minimum, the thermoexpansion valves were serviced one by one. Seven were returned to the system. Three were replaced, and one new thermoexpansion valve was installed to replace an outmoded hand expansion valve (Fig. 10).

All thermoexpansion valves were Sporlans. One had lost the charge from its power assembly, and passed liquid ammonia only because the needle did not seat into the orifice. Those which permitted flooding had the following faults:

1. Leakage at the seat.
2. Push rods were too long.
3. The feeler bulb was not strapped tightly to the vapor return pipe.
4. Though tightly strapped, the feeler bulb had rust or other foreign material between it and the pipe or adapter.

The needles and seats were polished or replaced. Too-long push rods were filed off. As each valve was replaced, a spot on the return line for the feeler bulb was cleaned with a mill file and emery cloth. The bulb also was cleaned with emery cloth, and clamped to the pipe on a new adapter.

These repairs and adjustments brought the system under complete control, with high superheat at the compressor manifold. The compressor ran quietly, and held proper room temperatures until the larger compressor was restored to service late in October, 1948.

The Meaning of Gravity of Fuel Oils

This is the third article by Mr. Schmidt on the characteristics of fuel oils. This one discusses the meaning of gravity, the method of testing gravity, gravity ranges in fuel oils and the information derived from gravity. A table showing specific gravity, the pounds per gallon and the number of gallons per pound is given, to eliminate figuring

By PAUL F. SCHMIDT

SINCE the early refining of petroleum, gravity of an oil was used extensively as a criterion characteristic, which in turn led to a number of misinterpretations, especially as different crudes and new refining processes appeared. Gravity is still an important item with both heavy and light oils, as it is easily obtained, and a number of approximate conclusions and pertinent information can be derived from it, but it would be foolhardy to base all your faith in gravity alone.

With modern refining methods, using many different crudes, a gravity specification does not mean or indicate anything definite or specific, as two oils with the same gravity can have many different characteristics, which means that there can be no uniformity in quality, if the gravity is the only specification listed.

Meaning of Gravity

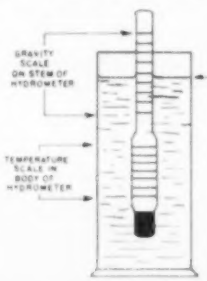
The gravity, or density, is the ratio in weight between that of an oil and water, at the same temperature. The oil industry uses the A.P.I. gravity scale. Occasionally, the specific gravity scale is used, but the A.P.I. is the official one.

Method of Testing

The gravity of an oil is found by allowing a standard hydrometer to float in a cylinder of the liquid. The hydrometer will sink until the calibration on the stem corresponds to the gravity of the oil, and the reading is then taken.

As the gravity varies with the temperature, due to the contraction and expansion of the oil, making it lighter or heavier, the temperature of the sample must be taken at the same time as the gravity reading is taken. As the standard temperature in the petroleum industry is 60 F, the gravity reading is corrected to this temperature from the various charts that are available for this purpose. For a close estimation, for every 10 deg increase in temperature, the gravity will go up one-half A.P.I. deg, and the same for each 10 deg decrease in temperature.

The starting point on the A.P.I. gravity scale is 10, which corresponds



Testing gravity by the hydrometer method

Table No. 1

Specific Gravity, Pounds Per Gallon, and Gallons per Pound, Corresponding to the Designated Degree, A.P.I.

A.P.I Gravity @ 60 F.	Specific Gravity @ 60 F.	Pounds per Gallon	Gallons per Pound
9.0	1.0071	8.388	0.1192
9.5	1.0035	8.358	0.1196
10.0	1.0000	8.328	0.1201
10.5	0.9965	8.299	0.1205
11.0	0.9930	8.270	0.1209
11.5	0.9895	8.241	0.1213
12.0	0.9861	8.212	0.1218
12.5	0.9826	8.183	0.1222
13.0	0.9792	8.155	0.1226
13.5	0.9759	8.127	0.1230
14.0	0.9725	8.099	0.1235
14.5	0.9692	8.071	0.1239
15.0	0.9659	8.044	0.1243
15.5	0.9626	8.016	0.1248
16.0	0.9593	7.989	0.1252
16.5	0.9561	7.962	0.1256
17.0	0.9529	7.935	0.1260
17.5	0.9497	7.909	0.1264
18.0	0.9465	7.882	0.1269
18.5	0.9433	7.856	0.1273
19.0	0.9402	7.830	0.1277
19.5	0.9371	7.804	0.1281
20.0	0.9340	7.778	0.1286
20.5	0.9309	7.752	0.1290
21.0	0.9279	7.727	0.1294
21.5	0.9248	7.701	0.1299
22.0	0.9218	7.676	0.1303
22.5	0.9188	7.651	0.1307
23.0	0.9159	7.627	0.1311
23.5	0.9129	7.602	0.1315
24.0	0.9100	7.578	0.1320
24.5	0.9071	7.554	0.1324
25.0	0.9042	7.529	0.1328
25.5	0.9013	7.505	0.1332
26.0	0.8984	7.481	0.1337
26.5	0.8596	7.458	0.1341
27.0	0.8927	7.434	0.1345
27.5	0.8899	7.410	0.1350
28.0	0.8871	7.387	0.1354
28.5	0.8844	7.364	0.1358
29.0	0.8816	7.341	0.1362
29.5	0.8789	7.318	0.1366
30.0	0.8762	7.296	0.1371
30.5	0.8735	7.273	0.1375
31.0	0.8708	7.251	0.1379
31.5	0.8681	7.228	0.1384
32.0	0.8654	7.206	0.1388
32.5	0.8628	7.184	0.1392
33.0	0.8602	7.163	0.1396
33.5	0.8576	7.141	0.1400
34.0	0.8550	7.119	0.1405
34.5	0.8524	7.098	0.1409
35.0	0.8498	7.076	0.1413
35.5	0.8473	7.055	0.1417
36.0	0.8448	7.034	0.1422
36.5	0.8423	7.013	0.1426
37.0	0.8398	6.993	0.1430
37.5	0.8373	6.972	0.1434
38.0	0.8348	6.951	0.1439
38.5	0.8324	6.930	0.1443
39.0	0.8299	6.910	0.1447
39.5	0.8275	6.890	0.1451
40.0	0.8251	6.870	0.1456

The data in Table No. 1 were taken from the National Bureau of Standards Circular C410

to a specific gravity of 1.000, which is the gravity of water at 60 F. Usually any reading about 10 is lighter than water, and likewise any gravity reading below 10 is heavier than water.

Comparisons between the A.P.I. and Specific Gravities are listed in Table No. 1. Included in this table are the weights of the various oils, corresponding to their gravities.

Gravity Ranges of Fuel Oils

The following gravity ranges are general, and not an exact figure, as they can vary with the different oils, due to types of crudes, refining processes and composition.

No. 2 fuel oil
A.P.I. gravity range 26 to 39
No. 4 fuel oil
A.P.I. gravity range 24 to 32
No. 5 fuel oil
A.P.I. gravity range 16 to 22
No. 6 fuel oil
A.P.I. gravity range 10 to 15

Naturally, as No. 5 and 6 oils are heavier than No. 2 and 4, so will the gravities be heavier.

As the gravities will vary among the various grades, so will they fluctuate among the different types, as shown in the following illustrations.

	A.P.I. Gravities		
	No. 2	No. 5	No. 6
Straight run fuel oils	36	17	16
	38	20	17
	39	22	18
Thermally cracked fuel oils	24	13	11
	28	14	12
Catalytically cracked fuel oils	29	—	—
	30		
	32		

No. 4 fuel oil, being a blended oil, will have varying gravities, corresponding to the percentage of the blending oils used, and type of blending components.

Information Derived From Gravity

The gravity of an oil can give the following information, and while not absolutely correct, the approximations are close enough for all general purposes.

1. The lower the gravity, the heavier the oil in viscosity; higher in carbon content, and heavier in weight.
2. The higher the gravity, the lighter the oil in viscosity; lower in carbon content, and lighter in weight.
3. Heat of combustion, or amount of heat liberated during the combustion of the oil.
4. Weight of the oil, as pounds per gallon.
5. Percentage of carbon and hydrogen present.
6. Type of refining process which produced the oil.
7. A fair indication of the grade of oil.

Items No. 1 and 2 will be discussed in later articles on Viscosity and Carbon. Item No. 3 will be explained in a later article on Heats of Combustion.

As the gravity goes upward, the weight of the oil decreases or becomes lighter. The reverse is also true, meaning low gravity, heavier in weight. Table No. 1 will show these figures.

The gravity can be used to determine the approximate amount of carbon and hydrogen in the oil. This carbon is the carbon of the hydrocarbon itself, and should not be confused with the carbon obtained in the carbon test, or during combustion. The formula for determining the percentage of hydrogen from the gravity was devised by the Bureau of Standards as follows: Per Cent Hydrogen = 26 — 15d. The letter "d" is the specific gravity. After determining the hydrogen content, subtract this percentage from 100 and the percentage of carbon is obtained.

As long as an oil is unblended, the gravity can show whether it is a straight run oil, or a cracked one. The straight run oils have higher gravities than oils that have been cracked, as shown earlier in this discussion.

By using the previous mentioned difference in gravities, among the various grades of fuel oils, one can ascertain with fair accuracy which grade an oil will be from the gravity reading.

In some cases the consumer requests an oil of a definite gravity. If the supplier does not have this particular gravity oil in storage, he occasionally blends various different oils together, either distillates or residuals, to obtain the required gravity.

A great number of purchasers and consumers of fuel oils, particularly with heavy residuals, want low gravity oils, as they expect to get the greatest amount of heat from these oils. This theory is correct in the majority of cases, but not 100 per cent, as we will see later. To establish a simple rule, that theory can be accepted as nearly correct.

CLEANING ELECTRICAL CONTACTS

By W. E. Warner

HARD PASTE ABRASIVES should be avoided for cleaning electrical contacts. It will be found that pieces of hardwood, kept roughened at the end by a stiff wire brush, will be sufficiently abrasive for removing dirt and oxide.

For cleaning commutators or slip rings, a block made of roughened hardwood is more effective than the usual sandpaper block. While it effectively removes dirt and oxide, it does not wear away the copper and there are no sandpaper particles to get dislodged and do damage.

THE PRACTICAL ENGINEER AND ELECTRICIAN

Basic Power Plant FIGURING

A Review for Old-Timers

A Must for Young-Timers

By WILLIAM H. ENGELMAN
Mechanical Engineer
Department of Water & Light
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HERE'S a good example of how you have to put fundamental engineering facts together to solve a specific power plant problem. You're not expected to carry all the facts in your head, although you must remember such things as 33,000 ft lb per min equals 1 hp or 8.33 lb per gal of water and so on. But you are expected to be able to put your hands on the information quickly in your own notebook or file or in some standard engineering handbook or textbook.

Most important of all, you've got to know how to look for the data you know will be needed to solve the problem. And finally, you've got to know how to use them correctly to get the right answer, which must come out in some definite quantity, such as so many feet of 4-in. Schedule 40 pipe that somebody must write out an order for.

To solve problems in all the Basic Power Plant Figuring articles, the author has attempted to include as many as possible of the data tables, graphs and formulas you will need. However, some things, like the complete steam tables, obviously cannot be included and you must have them in their complete form in any case, for accurate figuring. Certain other tables, such as the pipe friction tables referred to below, will have to be looked up in other publications or in previous articles of this series.

The data you need for solving the present pump problems are either on these pages, have been given in previous Basic Power Plant Figuring articles or are in standard handbooks you should own or have available. Here's a list of them.

REFERENCES

A—Friction Losses per 100 ft of 15-year-old ordinary iron pipe, by Williams and Hazen: *Piping Handbook*, by Sabin Crocker, 4th Edition, pages 280 and 281; (McGraw Hill Book Co.)

B—Resistance of Valves and Fittings to Flow of Fluids, Crane Co., Catalog No. 42, page 513

C—To Get Right Pump—First Find Pipe Friction Losses, by Carter and Karassik; *Plant Engineering*, December, 1947, page 24. This article includes the Williams and Hazen tables

D—To Get Right Pump—Figure Losses in Valves and Fittings, by Carter and Karassik; *Plant Engineering*, January, 1948, page 25

E—Tables A and B—Physical Characteristics of Schedule 40 and Schedule 80 Pipe; *Power Generation*, August, September, 1949

F—Thermodynamic Properties of Steam (the Steam Tables) by Keenan and Keyes (John Wiley & Sons, Inc.)

How to Calculate Steam and Water Piping and Power Requirements for Steam-Turbine-Driven Centrifugal Boiler Feed Pumps and Other Centrifugal Pumps

Friction Drop (loss of head) Due to Flow of Water in Piping

CALCULATIONS in the accompanying sketch, Fig. 1, are based upon loss per 100 ft of 15-year-old ordinary iron pipe taken from tables by Williams and Hazen, References A and C. Resistance of valves and fittings expressed in equivalent length of straight pipe, in feet, are taken from Crane Co. (Ref. B and see also Ref. D)

Suction		Friction Loss	
1—4 in. medium sweep el	9 ft	124 × 4.4/100	5.5 ft
1—Foot valve	100 ft	Velocity head	0.5 ft
1—4 in. pipe length	15 ft	Vertical lift	15.0 ft
Equivalent pipe	124 ft	Total suction lift	21.0 ft

Discharge		Friction Loss	
1—Check valve	120 ft	624.5 × 4.4/100	27.5 ft
1—Gate valve	2.5 ft	Vertical lift	125.0 ft
3—4 in. elbows	27.0 ft		
4 in. pipe length	475.0 ft	Total discharge lift	152.5 ft
Equivalent pipe	624.5 ft		

Total head = 152.5 + 21.0 = 173.5 ft
Rate of pumpage is 200 gpm

$$\text{Water hp} = \frac{200 \times 8.33 \times 173.5}{33{,}000} = 8.8$$ (See May issue, p 82)

At 50 per cent efficiency brake hp = 8.8 ÷ 0.50 = 17.6
Consider a steam-turbine-driven centrifugal pump with a steam consumption of 50 lb per brake hp-hr (water rate); we have:
17.6 × 50 = 880 lb of steam per hour or 14.7 lb steam per min.
The steam pressure is 150 psia; condition of steam, dry saturated.
Volume is 3.016 cu ft per lb (Ref. F)
Total volume per minute is 3.016 × 14.7 = 44.36 cfm.
1.0 in. std. pipe contains 0.0060 cu ft per linear foot (Ref. E)
1¼ in. std. pipe contains 0.0104 cu ft per linear foot
1½ in. std. pipe contains 0.0141 cu ft per linear foot
Velocity in 1- in. pipe would be 44.36 ÷ 0.0060 = 7,400 fpm
Velocity in 1¼-in. pipe would be 44.36 ÷ 0.0104 = 4,270 fpm
Velocity in 1½-in. pipe would be 44.36 ÷ 0.0141 = 3,150 fpm
The 1-in. pipe gives excessive velocity and would cause a large friction drop, hence the next larger pipe should be used.

Piping for Steam-Turbine-Driven Boiler Feed Pump, Fig. 2

Suction		Discharge	
2—4 in. medium sweep els	18 ft	3—4 in. medium sweep els	27 ft
2—Gate valves, 4 in.	5 ft	3—Gate valves, 4 in.	7.5 ft
Linear feet of pipe	75 ft	1—Globe valve, 4 in.	120.0 ft
		1—Check valve, 4 in.	120.0 ft
Equiv. linear ft	98 ft	1—Feedwater Regulator	120.0 ft
		2—4 in. tees, on run	14.0 ft
98 × 3.44/100 = 3.4 ft head		linear feet of pipe	285.0 ft
		Equiv. linear ft	693.5 ft
Net head = 75 − 3.4 = 71.6 ft		693.5 × 3.44/100 = 23.8 ft head	

Pressure at pump is 200 ÷ 50 = 250 lb × 2.31	578.0 ft hd
Vertical distance from pump to boiler	60.0 ft hd
Friction loss on discharge side	23.8 ft hd
Head required at pump on discharge	661.8 ft hd
Available net head on suction side	71.6 ft hd
Net Head	590.2 ft

$$\text{Water hp} = \frac{590.2 \times 2{,}000 \times 34.5 \times 1.25}{1{,}980{,}000} = 25.7$$

With 60 per cent efficiency: 25.7 ÷ 0.60 = 43.0 hr hp
Hourly steam consumption is 43.0 × 38 = 1635 lb per hr

Steam pressure in boiler	200.0 psig
Pressure drop, boiler to pump turbine	8.7 lb
At turbine =	191.3 psig
add	14.7 lb
	205.0 psia

Volume at 206.0 psia and 520 F is 2.709 cu ft per lb

$$\text{Volume per minute} = \frac{2.709 \times 1635}{60} = 73.85 \text{ or } 74.0 \text{ cfm}$$

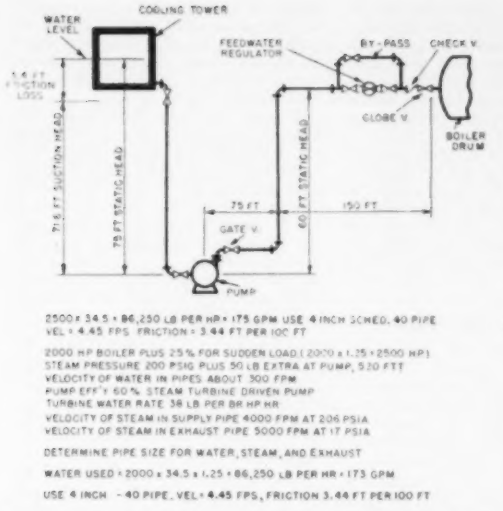
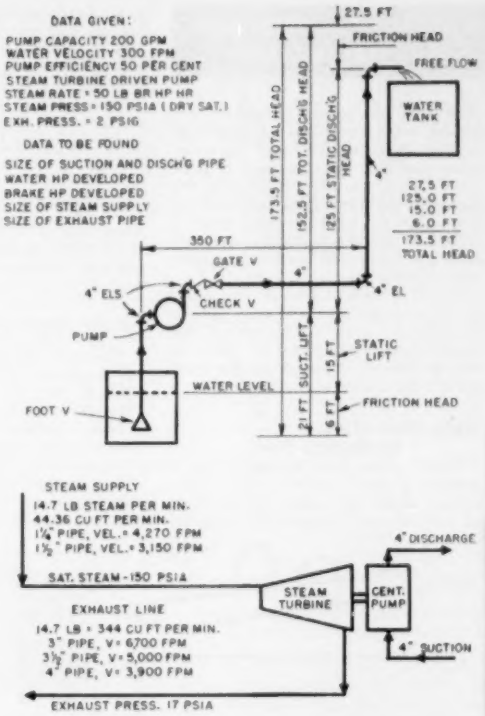

COOLING TOWER
WATER LEVEL
FEEDWATER REGULATOR
BY-PASS
CHECK V
GLOBE V
BOILER DRUM
1.4 FT FRICTION LOSS
71.6 FT SUCTION HEAD
79 FT STATIC HEAD
60 FT STATIC HEAD
75 FT
150 FT
GATE V
PUMP
2500 x 34.5 = 86,250 LB PER HR = 175 GPM USE 4 INCH SCHED. 40 PIPE
VEL = 4.45 FPS FRICTION = 3.44 FT PER 100 FT
2000 HP BOILER PLUS 25% FOR SUDDEN LOAD (2000 x 1.25 = 2500 HP)
STEAM PRESSURE 200 PSIG PLUS 50 LB EXTRA AT PUMP, 520 FTT
VELOCITY OF WATER IN PIPES ABOUT 300 FPM
PUMP EFF'Y 60% STEAM TURBINE DRIVEN PUMP
TURBINE WATER RATE 38 LB PER BR HP HR
VELOCITY OF STEAM IN SUPPLY PIPE 4000 FPM AT 206 PSIA
VELOCITY OF STEAM IN EXHAUST PIPE 5000 FPM AT 17 PSIA
DETERMINE PIPE SIZE FOR WATER, STEAM, AND EXHAUST
WATER USED = 2000 x 34.5 x 1.25 = 86,250 LB PER HR = 173 GPM
USE 4 INCH - 40 PIPE, VEL = 4.45 FPS, FRICTION 3.44 FT PER 100 FT

Fig. 1. Diagram of piping to be calculated by the methods shown in the text, for 200-gpm steam-turbine-driven centrifugal pump discharging to tank



STEAM SUPPLY
14.7 LB STEAM PER MIN.
44.36 CU FT PER MIN.
1¼" PIPE, VEL. = 4,270 FPM
1½" PIPE, VEL. = 3,150 FPM
SAT. STEAM - 150 PSIA
4" DISCHARGE
STEAM TURBINE
CENT. PUMP
4" SUCTION
EXHAUST LINE
14.7 LB = 344 CU FT PER MIN.
3" PIPE, V = 6700 FPM
3½" PIPE, V = 5,000 FPM
4" PIPE, V = 3,900 FPM
EXHAUST PRESS. 17 PSIA

Fig. 2. Right: Diagram of piping to be calculated by methods shown in text, for steam-turbine-driven centrifugal boiler feed pump serving 2000-hp boiler

Volume in cu ft per lin ft of pipe from piping data sheet, Ref. E:

1¼ Std. pipe	= 0.0104 cu ft	velocity = 74.0 ÷ 0.0104	= 7,120 fpm
1½ Std. pipe	= 0.0141 cu ft	velocity = 74.0 ÷ 0.0141	= 5,250 fpm
2 Std. pipe	= 0.0233 cu ft	velocity = 74.0 ÷ 0.0233	= 3,175 fpm
2 Ex. Hy.	= 0.0205 cu ft	velocity = 74.0 ÷ 0.0205	= 3,600 fpm

Volume of exhaust steam at 2 psig or 17 psia is 23.4 cu ft per lb.

$$\text{Volume per minute} = \frac{23.4 \times 1635}{60} = 638 \text{ cfm}$$

4 in. Std. pipe	= 0.0884 cu ft	vel. = 638 ÷ 0.0884	= 7,180 fpm
5 in. Std. pipe	= 0.1389 cu ft	vel. = 638 ÷ 0.1389	= 4,600 fpm

PRACTICAL HINTS AND KINKS

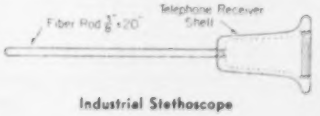
STETHOSCOPE FOR THE MAINTENANCE DOCTOR

By W. T. WIDMAIER
Westinghouse Electric Corporation

MOST MODERN devices are designed with the idea of eliminating the need for the use of our so-called gray matter. While eliminating the personal element tends, in many cases, towards perfection in mechanical operations, that goal is often obtained with a greatly increased cost in tooling. For many operations where the additional cost is not warranted due to idle time of the particular tool in question, a simple low cost device can be constructed. It must be remembered, however, that in most such cases a considerable degree of personal judgment in its use is required.

A maintenance tool of this nature can be used for determining what goes on inside a ball bearing. It is easy to make, and with a little experience, is easy to use and evaluate the results. The only items required are a piece of fiber rod ⅜ in. in diameter and 20 in. long, threaded at one end for a half inch with a standard ⅜ in. thread cutting die, and an old telephone receiver shell with a ⅜ in. tapped hole in the small end. If the old telephone receiver is not available, obtain a fiber or micarta tube 1½ in. in diameter and 6 to 8 in. long. Turn a hard wood block to fit one end and drill and tap this block for the ⅜ in. fiber rod.

In operation the end of the fiber rod is placed against the bearing housing and the ear is placed against the open end of the receiver or tube. After a short time the operator becomes proficient in distinguishing between the noises that mean trouble and those that denote normal performance. A steady hum indicates that the bearing is O.K. If bearing is dirty a click will be heard at irregular intervals. If flat spots start to develop, there will be a click at regular intervals and this



Industrial Stethoscope

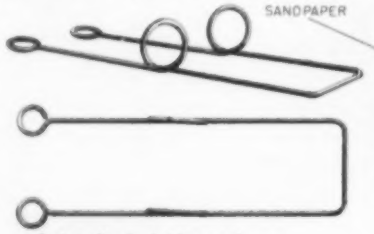
click will get progressively louder as the wear increases. A crack or fatigue spot on the inner or outer races will also show up as a regular click. As a matter of interest, the man who developed this tool tells us that it is so sensitive that after a little practice the moving grease can be heard when the bearing has been over-lubricated.

There are about four or five noise levels that the operator soon gets to distinguish and from which he draws his conclusions of what is wrong and about when the bearing should be cleaned or replaced.

TOOL BOX CLIPS

By FRANK J. TRAIL

EVERY TOOL box should have a supply of sand paper, emery cloth, crocus cloth, etc., but the problem is, how to carry this useful material



Spring clips for holding sandpaper

and yet not have it mixing up with other materials and tools in the tool box.

A simple method of carrying sandpaper is by means of the spring clips shown in the accompanying illustration. This clip is attached to the inside of the tool box lid as shown. In this way, sandpaper is always handy, yet out of the way.

THE DIAGONAL SCALE

By ALBERT H. MOULTON

THE DEVICE illustrated in the accompanying illustration is not new but it is one that is very useful and not very well known. I have talked about it to several engineers and draftsmen but so far, no one I have encountered has heard of it. It is called the diagonal scale and it is used to measure small units of length to one, one hundredth of an inch or other units. Its construction is obvious from the illustration and it is simple to use. For example, to lay off 0.05 in., follow the diagonal line 0 down to horizontal line 5. Where the lines intersect read 0.05 in. from the vertical line. To lay off 2.73 in. follow diagonal line 7 down to horizontal line 3. Set the dividers at this point and at 2 on line 3 and measure 2.73 inches as indicated by x-x. In this way any linear distance can be measured to one hundreths of an inch. To measure distances on drawings or maps, merely set the dividers on the given points and the distance is then easily found by this scale.

NOVEL NEW WHEELBARROW

WILLIAM GEMEINHARDT, mechanical engineer and member of the staff at New York University College of Engineering, has developed a new wheelbarrow, the design of which has a number of advantages over conventional types.

The new vehicle has an ingenious suspension which provides for the wheel to swing longitudinally. While an ordinary wheelbarrow can be forced across a sharp curb 4 in. high only by causing a severe shock to the operator, load and barrow, the new type rides over such a curb with relative ease.

During the past four years, the new wheelbarrow has been tested on a number of construction jobs including the current project on the new gymnasium at New York University. When the new vehicle is used, elaborate plank tracks are unnecessary, road shocks are absorbed, fatigue of operators is reduced, greater loads can be carried without danger of spilling. Obstacles are crossed with ease, detouring around small holes and ruts is unnecessary, dumping is relatively effortless, and wedges at normal curbs are not needed.

The new wheelbarrow employs a new principle of operation. Abrupt, jerky movements of the wheel are transmitted to the vehicle by the swinging suspension a smooth wave-like gliding movement. Lever

Fig. 1. The New Wheelbarrow in use

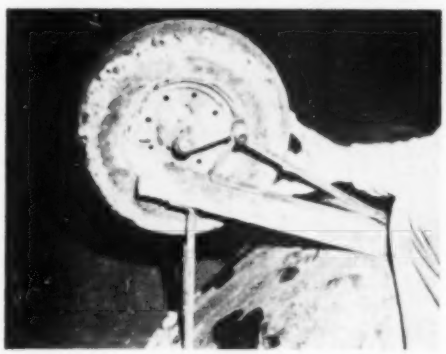
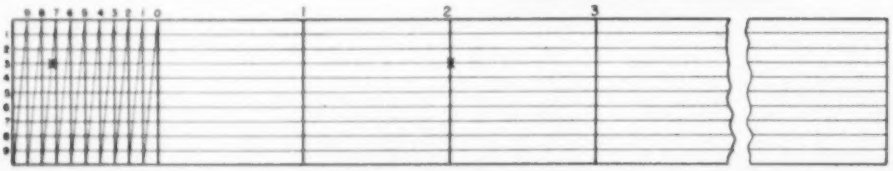


Fig. 2. Details of construction of the new wheelbarrow



Diagonal scale for measuring to hundredths of an inch

action of the suspending arms converts forward momentum into a lifting action that eases the weight of the barrow up onto the top of an obstacle thus eliminating need for raising effort by the operator.

William Gemeinhardt is now working on designs which will apply the same swinging suspension to cross country vehicles.

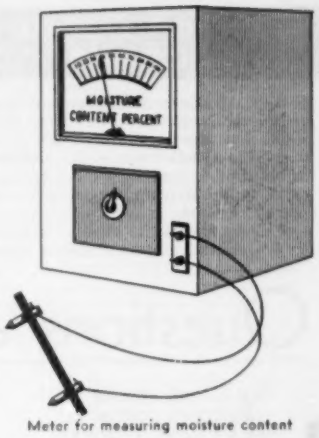
MOISTURE CONTENT OF WOOD PRODUCTS

MOISTURE PRESENT in the wood is an important factor in the manufacture of wood products such as tool handles and ladders. Wood that has too much moisture content will shrink, warp or split.

Due to our interest in safety we have always been interested in this problem and we were therefore pleased to learn of the development of an electrical moisture measuring instrument that will accurately check the moisture content of wood products. This meter instantly indicates the amount of moisture at any point on a wood item.

The set consists of two pin points mounted on a test prod which is connected by a flexible cord to a special ohmmeter assembled in a portable carrying case.

The test is made by driving the test prod into the wood specimen and measuring electrical resistance between the two pin points of the prod. The moisture content is proportional to the electrical resistance between these points. This can be quickly determined by simple adjustment of the test set which is calibrated to read percentage of moisture content directly.



Meter for measuring moisture content

Automatic Degasser for Steam Sampling in Power Plants

FOR MEASURING purity of condensed steam, electrical conductivity procedures are widely preferred. Because gases such as carbon dioxide and ammonia contribute to the conductivity, as do dissolved salts carried over from the boiler, interpretation of conductivity measurements may be somewhat uncertain. To solve this problem, a new degasser has been developed which automatically splits a steam sample into two approximately equal streams of condensate, one containing all solid impurities, the other containing all gaseous impurities in the original sample. Both streams pass through conductivity flow cells so the degree of contamination can be measured continuously by conductometric means.

Ample experience in the past has shown how difficult it is to remove dissolved gases from steam already condensed. The degasser to be described eliminates this problem altogether, simply by preventing the gases from becoming dissolved to any appreciable extent in the first place.

The schematic diagram shows the principal parts of the degasser. Operation is as follows:

1. Steam, throttled to between 15 and 100 psig, enters the double reboil coil A, immersed in a condensate pool in the separator. Heat exchange takes place between the fluids inside and outside of the coil. Steam in the coils is partially condensed before discharge through orifices, and condensate in the pool around the reboil coils is continuously boiled to eliminate traces of gases.

2. Uncondensed steam passing upward in the separator contacts the outside of the revaporizing chamber B. Partial condensation occurs, with water returning to the pool around the reboil coil A. The residual steam, containing gases, goes out the top of the separator.

3. The steam containing the gases ("gas fraction"), after leaving the separator, is completely condensed in condenser C.

4. The condensate leaving C is passed into revaporizing chamber B, where it absorbs heat from the steam on the outside and is completely vaporized, effecting the partial condensation in the separator, as mentioned in 2.

5. The gas fraction leaves the revaporizing chamber in the separator, is then condensed and cooled in condenser D, passes through conductivity flow cell G, and overflows to waste.

6. The water in the pool surrounding the reboil coil A contains the solids originally present in the steam but essentially no gases. This "solids fraction" overflows into a float chamber from which it issues continuously through float valve F.

7. The solids fraction is then cooled in cooler E, passes through conductivity cell S, and overflows to waste.

The degasser is manufactured as a commercial machine by Hagan Corp.

The degasser is quite simple to install and can be moved from place to place with ease. It is described in detail, with discussion of field experience and analysis of heat balance in a paper by H. M. Rivers and W. H. Trautman of Hall Laboratories, Inc. and G. W. Gibble, formerly of Hall Laboratories and now with Arabian-American Oil Co., before the 1949 Annual Meeting of ASME.

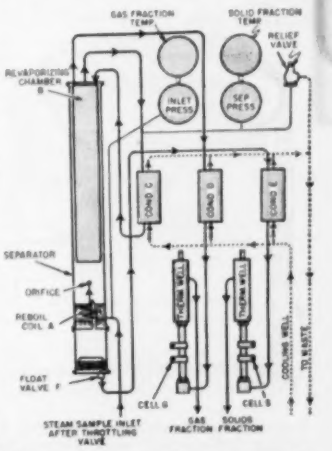
Summing up the features of this new degasser, the authors pointed out that:

1. Under normal operating conditions substantially all ionizable gases are removed from the solids fraction. Even in extreme cases 95 per cent or more are removed.

2. Because of the inherently stable thermodynamic cycle employed, operation is automatic and cannot be affected materially by even abnormal changes in boiler operation.

3. Since steam and condensate flowing to the cells contact only stainless steel, minimum pickup of contaminants is assured.

4. The time interval from entrance of steam into the degasser to the



Schematic diagram of new automatic degasser

passage of degassed condensate out of the conductivity flow cell for the solids fraction is of the order of 1 min. This avoids the averaging effect in blunting or spreading out momentary conductivity changes over a period of time.

5. Since the lag is small, conductivity-recorder charts made in conjunction with the degasser can be compared readily with steam flow, superheat temperature, or other operating charts to obtain a coherent over-all picture of the data.

6. The conductivity of the gas fraction is measured simultaneously by a second cell. The gas fraction can also be easily diverted for chemical analysis.

* For instructions on making conductivity test, see article The Conductivity Test—Important in Boiler Water Control, by John Drew Bietz, POWER GENERATION, December, 1948.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your question from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

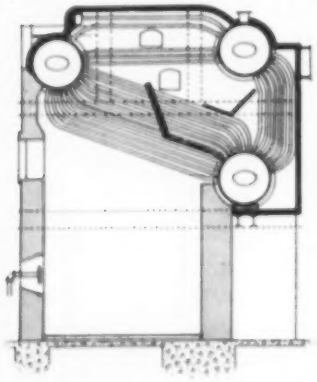
If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it? And effective! Just ask engineers who have tried it!

Question No. 463

SHOULD HE WASH FIRE SIDES OF THIS WATER-TUBE BOILER?

I UNDERSTAND it has become a practice, in many power plants, to wash with water the fire side of boilers when it is not necessary to rattle tubes for internal scale. We use the by-product of our lube oil plant for fuel; this contains salt and dirt of crude oil, which leaves a heavy deposit on the tubes. Internal surfaces of our boilers do not require cleaning. We hesitate to use water on the outside of the tubes because we do not know what effect it will have upon the setting of the boilers.



Section of 3-drum water tube boiler by C. B. showing baffle, which would form pocket and catch dirt from washing tubes. How could he avoid this?

What is your opinion of this practice? Would there be any damage to the settings? Should the boilers be allowed to cool before washing? Is there any damage to the baffle?

We have type C, three-drum boilers, as shown in the sketch. On this type of boiler, the baffle is inclined about 45 deg from the horizontal and butts up against the drum at the bottom end making a pocket. If water is used to wash the tubes, it would wash dirt into this pocket. How would we get the water and dirt out of this pocket?

I feel we could save time in cleaning boilers if we could use water; but I would like to know more about the possibilities of damage before I try it. I would like to know some of the experiences of Q & A readers.

Coffeyville, Kansas C.B.

Question No. 464

IS HIS SUBSTATION GROUND GOOD?—AND HOW CAN HE TELL?

WE HAD quite a bit of trouble with lightning last summer and were advised to check our substation ground with an ohmeter. The ground bus is connected to heavy cables that run out to the bed of a nearby creek.

For various reasons we did not make this test but now want to do so; but we are not sure just how to do it. Will you please tell us how we can determine whether a ground is good or not?

Between what points should an ohmeter be connected?

Aspen, Colo. A.D.A.

Question No. 465

HOW CAN SOLDER BE COLORED SAME AS METAL USED ON?

I HAVE BEEN reading *Power Generation* and *Power Plant Engineering* for a good many years and some time ago you published a little article telling what chemicals to put in solder to give it the same color as copper or brass. I have lost the item and need to have this information again. Can you find it for me? Or can Q&A readers give me any information on it?

Detroit, Mich. F.J.M.

Editor's Note:—Yes, we have some information on this, but before publishing it would like to know what methods other readers may recommend.

Answer No. 445

WHAT TREATMENT PREVENTS SCALE AND CORROSION IN DRINKING WATER SYSTEMS?

CAN MATERIALS such as sodium tetraphosphate, which can be purchased on the open market, be used in treating water for human consumption without infringement of any patents? asked J.W.B.

In the October issue, a reader answered "Yes" and cited some legal decisions in support.

Now, however, another reader has informed us that there is a patent covering the use of sodium tetraphosphate in water treatment, as noted in the letter below.

It is not our function to try patent cases in these columns. But we now have a letter stating that the previous answer was wrong and might lead somebody to a patent infringement. Therefore since we never wish to lead any reader into such a situation, and since the original questioner wanted exactly this information, we issue this **CAUTION:**

Before using sodium tetraphosphate in any water treatment process, consult your company's patent lawyer for advice on the possibility of patent infringement.

Patent Covers Process But Not Chemical

ANSWER No. 445 on page 80 of POWER GENERATION for October 1949 just came to our attention and we hasten to point out that it is likely to induce infringement of Fink and Richardson U. S. Patent 2,358,222 owned by National Aluminate Corp.

The question asked was whether sodium tetraphosphate may be *used* in water treatment for human consumption without infringement of any patents. The answer was an unqualified "Yes."

The answer begs the question by stating that a patentee has no right to control the sale of unpatented chemicals or materials. Of course, a patentee has no right to control

the *sale* of unpatented chemicals or materials but he has the right to prevent the use of a process specifically covered by the patent.

National Aluminate Corp. grants licenses on a royalty basis to those who participate in the practice of the process covered by the claims of the aforesaid Fink and Richardson patent. The licenses are unrestricted as to the source of supply of the unpatented chemicals used in the process. This licensing practice is not in conflict with the decisions referred to in Answer No. 445. The reader who answered the question seems to have confused the sale of the material on the one hand with its use in water treatment on the other. The purchase or sale of the material cannot be controlled by the patentee but the use of an infringing process can be enjoined by suit against the user of the process.

For these reasons, it should be made clear that the use of sodium tetraphosphate in water treatment for human consumption as covered by the claims of the Fink and Richardson patent constitutes an infringement of such claims and that the user, in order to avoid such infringement, should obtain a license under the patent.

Chicago, Ill. F. H. THORNE

Answer No. 454

HOW CALCULATE HEATING COIL FOR OIL STORAGE TANK?

WHAT IS the method, asked R.H.B. in the March issue, for calculating the size and length of piping or tubing for steam coils necessary to maintain No. 6 fuel oil at 140 to 160 F in various sizes of fuel oil storage tanks, both underground and above ground?

Better to Heat Oil as Withdrawn, by Using Oil Heater, says Small

R.H.B. INDICATES that he wants to keep the entire contents of a fuel oil tank at 160 F with steam coils. This is the hard way of doing it, and it is, in general, more desirable to install a suction oil heater and heat only the required oil as it is withdrawn.

A suction oil heater usually consists of a bundle of U-bend tubes or a helical coil inside a cylindrical shell or sheath extending through the wall of the tank. One end is open in the tank and the other is connected to the suction line.

The withdrawal is definitely away from the tank shell. It is fair to assume that the oil temperature near the center of the tank is 20 F, the outer portion of the oil serving as insulation.

A rough idea of the tube surface required for the tubes inside the sheath is given by this formula

$$S = Gph \times 0.23 \times (\log_e \frac{T}{t})$$

in which

S is tube surface in square feet.

Gph is gallons of oil withdrawn per hour.

T is steam temperature minus tank temperature, the latter assumed to be 20 F.

t is steam temperature minus desired oil temperature.

$\log_e$ means log to the base e, given in standard handbook tables.

With steam under 25 psig, the factor 0.23 should be increased to 0.275.

For example, to heat 500 gph of No. 6 oil from 20 F to 120 F with steam at 100 psig, saturated steam temperature 337 F.

$T = 337 - 20 = 317$

$t = 337 - 120 = 217$

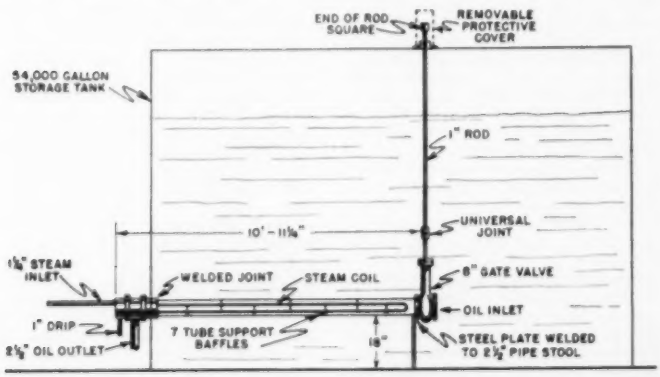
$T/t = 1.46$ and $\log_e$ of $1.46 = 0.3784$

(If you do not have a table of logs to base e you can figure same by taking the common log to the base 10 and multiplying it by 2.30.)

Then $S = 500 \times 0.23 \times 0.3784 = 43.5$ sq ft of tubing.

Steel is preferred material for tubing or pipes for this service.

Chicago, Ill. E. S. SMAIL



Typical storage tank oil heater, as constructed by W. F. Lorge and described in January, 1950 issue, page 84. This is the method mentioned by E. S. Small above. If you prefer to purchase a heater, most of the manufacturers of heaters have them, either with plain tubes or equipped with longitudinal finned tubes and with shell for installation within tank

Answer No. 458

HOW OFTEN SHOULD WE OVERHAUL OUR DIESELS?

HIS 300-HP DIESEL engine generator set, supplying power to his small factory, was purchased three years ago, has operated satisfactorily ever since, has never been shut down for a maintenance overhaul, and gives no outward sign that it needs one, said C.D.M. in the March issue. Should it be shut down now for a complete overhaul? he asked, having in mind all the advantages of a good preventive maintenance program, as given in previous issues of POWER GENERATION and its companion magazine PLANT ENGINEERING. Also, asked C.D.M., is there any general practice in determining the number of hours a Diesel engine should run between overhauls?

For 3 years, this engine has been operating an average of 8 hours a day, 5 and 6 days a week. The fuel consumption remains practically the same as when the engine was new; the increase in lubricating oil consumption seems negligible.

Overhaul Now, says Tatman

YES, BY ALL MEANS give the engine a general overhaul now. One would never think of running his private automobile three years without taking it into the garage for a check-up. The first three years of most any kind of engine will always be the most trouble-free years. After that, one will find that maintenance cost will start. But, with proper maintenance scheduling and inspection, it will never be excessive, and it will definitely pay good dividends.

To recommend a definite maintenance schedule for this Diesel engine, with no more information than is given, would be as unpractical as for a doctor to prescribe a medicine for a man who writes him saying that he is sick. Also, it would be just as unwise for anyone to follow any maintenance schedule given by someone that knew no more about this engine or its operating conditions than is given above.

Before one could recommend a good maintenance schedule, one should know the make, bore and stroke, speed. Is it a two or four-stroke cycle engine, full Diesel or semi-Diesel? Make and type of injection systems? Condition under which the engine operates, such as if the air is dry and dusty or clean and damp or if it breathes manufacturing fumes? Lubricating oil systems, cooling systems and air cleaners?

All these items must be taken into consideration before attempting to make up a maintenance schedule. The one unfailing source of information for this is the manufacturing company that built the engine. They are always glad to give an owner or user of their engines any help they can to keep the engines running in a satisfactory manner.

Also, only the manufacturer can give you the proper clearances for bearings and other moving parts that now must be readjusted after three years of wear.

There is no stock answer for all clearances. There are, however, a few safe averages that one may use until the proper clearance can be obtained. They are as follows: Piston rings—in groove, a tolerance of 0.004 in. to 0.006 in. must be given and an end gap clearance of 0.003 in. per inch diameter of cylinder. For bearing clearance allow 0.001 in. for each inch diameter of the journal up to 8 in. diameter and 0.00075 in. per inch diameter of the journal for all larger than 8 in. Thrust bearings are usually given 0.003 in. to 0.005 in. clearance on each end or a total of 0.006 in. to 0.010 in.

Never run an engine with a variation of over 0.005 in. wear between any main bearings. Wear of 0.005 in. or over will call for crank shaft realignment. This is very important, as it may lead to a broken crank shaft. No engine should be run over 5,000 hr without a general overhaul and it should have an inspection once a month.

In conclusion, I say again: Abide by the engine manufacturer's instruction book and recommendations and you cannot go wrong.

Ramey Air Force Base
Puerto Rico — W. O. TATMAN

Answer No. 459

HOW OFTEN SHOULD STANDBY DIESELS BE RUN?

IS IT ALL RIGHT to allow our two 75-kw standby Diesel generator sets to stand idle until needed for service, which may be a month or more, or should they be run every two weeks or oftener? asked C.F.M. in the April issue.

They are used in case of power failure, but he does not want to operate them more than necessary, in order to keep them in good condition. He has a battery charger to keep the starting batteries up where they belong. He uses a No. 2 Diesel fuel oil and a special crankcase oil.

Better Test Them Once a Week, says Freyberg

IF C.F.M. has automatic starting devices for his Diesels, so that they are on line in 10 sec or so after the power fails, he should be testing them weekly, at least, if only to make sure those automatic features work.

If no such starting system is used, and power can be more or less leisurely restored by manual operation of the air, then a two-week cycle may be adequate.

I can appreciate C.F.M.'s desire to not operate his Diesels more than necessary, so as to keep them in good condition, but if he does not institute a test-start schedule he will some day find that his main power source has not failed for some 3 or 4 months and that his long-idle Diesels will not start at all, because of rust and scale, or will wipe bearings when they do start, because of inadequate lubrication.

Buying a standby source of power, and then not keeping it in operating condition, is like burying your money in the ground. The scheduled test runs are the premiums you pay on your insurance to keep it in force. A half-hour's run once a week will mean he will have to overhaul the engines once about every 20 years to make up for the wear and tear.

Pleasantville, N. Y. — RICHARD H. FREYBERG

Test Every Two Weeks, Says Butcher

I WOULD RECOMMEND that Diesels be operated once in two weeks for a sufficient length of time to warm them up to normal operating temperature. If they are left until needed, it may be too long some time, because of corrosion.

Cincinnati, Ohio — IRA A. BUTCHER

Answer No. 460

WANTS ELECTROMAGNET TO REMOVE STEEL SHOT FROM BOILER HEADERS

THEY WOULD like to make an electromagnet, said R.C.I. in the April issue, to remove steel shot from boiler headers in the course of manufacture. These headers range in size from 10 in. I.D. to 20 in. I.D. and the magnet would have to pass through elliptical 3½ by 5-in. hand holes in the headers. How can he design and build such a magnet?

Use Permanent Magnet Rather Than Electromagnet, says von Dannenberg

THE WRITER has had to remove metal scraps and chippings from narrow tanks such as transformer tanks, and through small openings in them, and this problem is quite similar to that in the boiler headers mentioned. The writer has always been able to do this successfully by using some type of permanent magnet of suitable form, attached to a flexible wire or strong cord. In some cases, he has used a wooden rod with the magnet attached to its end in such a way that it can be directed into crevices and corners where close application is required.

Design and construction of such a permanent magnet can be developed to suit the conditions of the application. There are many specially-developed materials from which excellent permanent magnets are constructed. If R.C.I. has access to a scientific instrument supply shop, he will be able to find there many different types of permanent magnets.

One of these is the famous Alnico magnet. Also, excellent results have been obtained with the familiar horseshoe magnet, especially when it is made up of a number of thin magnets combined into one unit. The result is an extremely strong field between the closely adjacent poles, producing a high attractive strength in a small area.

Use has also been made of magnets taken from watthour meters, for these magnets have poles close together.

Finally, a simple rod magnet similar to the type formerly used in the old long-type telephone receivers has been used successfully in extracting particles from small-diameter tubing; but these do not have the attractive ability developed by the other types of magnets with two poles close together.

There does not seem to be any particular advantage in developing an electromagnet for this purpose. For one thing, a magnet might have to be used in conditions where direct current is not readily available (as is would have to be for an electromagnet) and in such a case, a portable battery or some other d-c source would have to be provided.

The only theoretical advantage of an electromagnet might be the ability to place it, un-energized, at the exact point where the material is to be extracted, and then turn on the power. However, the writer's experience has not shown that this would be an important advantage.

Brooklyn, N. Y. — C. O. VON DANNENBERG

Use Alnico Magnet

FOR THE REMOVAL of steel shot, an Alnico permanent magnet of great strength and any size, up to several pounds in weight, may be obtained from General Electric Co., from the Central Scientific Co. or others. These magnets are made in various shapes, are used on magnetic separators of many types and have great holding capacity.

Cincinnati, Ohio — IRA A. BUTCHER

Answer No. 461

WHY DO THRUST BEARINGS WEAR OUT?

IN THE April issue, J.T. showed the accompanying diagram of his single-width, single-inlet fan equipped with vortex control and inlet box, driven by two motors, coupled one on each end with flexible couplings. One is the low-speed, 60-hp, 865-rpm motor; the other 125-hp, 1165-rpm high-speed motor.

On this fan, thrust bearings have been wearing out rapidly; they have used eight since February 1947. They have changed to lighter grease, realigned shaft and couplings. The fan is installed outdoors on the roof.

They are using SKF No. 22222 spherical, self-aligning roller bearings. Shaft is 4-13/16 in. in diameter.

The boiler is rated at 150,000 lb per hr and has been operating at about 110,000 lb per hr, with the fan running at the high speed and the louvers about 1/3 open.

Do they get too much thrust? Should they house and heat the bearing in winter? Or install

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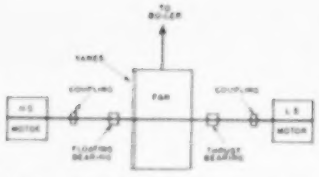

Diagram of J. T.'s fan driven by two motors, showing location of bearings, couplings and thrust bearing

heavier bearings? The bearings do not give any warning by overheating.

Bearings O.K. but Require Oil, Not Grease, says Meier

J.T. SHOULD run the rollers in an oil bath.

Use a heavier grade of oil in the summer, lighter grade in the winter. I have found that grease lubrication on outside installations is the chief cause of trouble in winter.

The SKF No. 22222 bearing is large enough—61,000 lb capacity. From page 3 of the SKF catalog, you will get the following specifications for spherical bearings: dn = 100,000 for grease and dn = 150,000 for oil. Now the bore of this bearing is 110 mm and n = 1165 rpm; so we have dn = 110 × 1165 = 128,000, indicating this bearing requires oil.

Check the flange diameter of the bearing retainers. If too large, they will squeeze the tips of the races and cut the rollers.

The installation is OK—allowance is made for expansion and contraction.

The above applies to spherical bearings only.

Chicago, Ill. FRED MEIER

Look at the Flexible Couplings, suggests Fisher

THIS QUESTION brings to mind a difficulty we have had with motor drives on boiler feed pumps, although it has usually occurred on larger and higher speed motors than those described. However, it is offered as a suggestion of something to check on. I do not say it is the cause of the trouble but it is well to look into it.

The difficulty I mean arises from the fact, that, due to causes as yet undetermined, flexible couplings will sometimes crowd the motor rotor to one end of its travel and produce an excessive pressure on the face of the bearing shell. This shell is not designed to take very heavy loads and the lubrication is only casual because only a portion of the oil picked up by the oil rings reaches the bearing ends. Therefore any unusual end thrust is pretty sure to cause trouble.

The remedy is to install limited end play couplings so that motor rotors have less play than the clearance between the collars on the rotor shaft and the inside of the bearing shells. Locate these couplings so that the rotors always float in the clearance space without the collars touching the bearing shells at either end. The present couplings can probably be altered to do this at a minor cost.

In the case of larger, higher-speed motors, if the driven equipment has forced oil circulation, it is well to extend this to the motor bearings.

New Haven, Conn. H. D. FISHER

Editor's Note:—It is interesting that, in a recent meeting of engineers operating large and important utility power plants, this same point was raised about the troubles that arise when flexible couplings allow motor rotors on pumps and fans to swing over, so that shaft collars rub on bearing shells.

Whether or not the cause of the thrust bearings wearing out fast will be found in the flexible couplings, we don't presume to suggest. But after listening to the discussion in that meeting, we think it is something J. T. should certainly look into.

Question No. 462

WANTS INSTRUCTIONS FOR BOILING OUT A BOILER

PLEASE give me full details on how to boil out a boiler.

Chicago, Ill. E.S.N.

Following detailed instructions are given in the textbook *Combustion Engineering*, First Edition, pages 30-24 and 30-25; published by Combustion Engineering-Superheater, Inc.

Boiling-out

A NEW BOILER, or one that has undergone extensive repairs, will usually contain considerable grease or oil, and this must be removed by boiling-out. For this process, a chemical charge is used in the proportion of 1 lb of caustic soda and 1 lb of soda ash per 1000 lb of cold water that is required to fill the boiler (and waterwalls, if installed). This charge is dissolved in water and introduced into the boiler, which is then filled with water to the normal starting level. A light fire, sufficient to raise pressure, is maintained for a period of 24 to 48 hr.

Tri-sodium phosphate is recommended as a substitute for soda ash. It is used in the same proportion: 1 lb per 1000 lb of water.

The chemical charge can be increased if the boiler contains excessive quantities of oil. In some references, there will be found charges as high as 7.5 lb caustic soda and 7.5 lb soda ash per 1000 lb of water to fill the boiler.

There are on the market, under various trade names, several cleaning compounds which can be used. When using these, the strength of solution and the boiling-out procedure should follow the manufacturer's instructions.

When boiling-out, it is most important to keep the boiler water hot and circulating. Successful cleaning cannot be accomplished otherwise, regardless of the cleaning chemical or the strength of solution used.

Start with a very low fire, and raise the boiler pressure to about 50 psi in 4 to 6 hr. Keep the superheater outlet vents or drains open. Also, in the steam lines beyond the superheater outlet, open any drains that can be used to take additional steam from the superheater, so as to increase the circulation of the boiler water. All steam taken from the boiler should pass through the superheater elements. Drains in the saturated steam header, and boiler vents, should be closed.

When the pressure reaches 50 psi, check all boiler circuits to see that they are hot. Waterwall header cover panels can be left open so that downcomer and riser tubes are accessible. Now, continue raising the pressure slowly until all the circuits are hot, and then maintain this pressure until satisfied that the boiler is clean. Usually, a period of 24 to 36 hr after the boiler is hot is sufficient to remove the oil and grease from a newly-erected boiler.

Drain the boiler while it is still fairly warm, and then open and wash it down with a hose, using clean water at fairly high pressure.

Inspect the boiler carefully, to make sure that no traces of oil remain. At this time, a careful inspection should also be made to see that all foreign material, dirt, scales, welding spatter and metal chips have been removed from the drums and headers. This material, if left in the boiler, usually fouls the safety valves and the blow-off valves, or it may pass into the turbines or engines. Practically all safety-valve troubles during preliminary operation of a new boiler are the result of damaged seats caused by foreign material from the boiler.

Editor's Note:—The above are the most recent instructions we have seen on boiling out. If Q&A readers have any other suggestions or experience in this subject, let's have them.

In riveted boilers, many engineers feel the use of caustic soda may promote embrittlement by filling seams with caustic. Some of the manufacturers of chemicals for water treatment have developed special boiling-out compounds designed to avoid this possibility. For example, one such compound is a combination of organic embrittling inhibitor, special oil emulsifier and sodium sulphate.

The oil emulsifying agent is claimed to be five times as effective in oil emulsification as caustic soda. Any seams are filled with the organic inhibitor, it is stated, and no caustic soda can possibly get into them during the boiling-out. The organic material is designed to be especially effective in penetrating fine cavities between joints or around rivet holes, while the sodium sulphate fills up large openings.

Dosage of this compound should be 25 lb per 1,000 gal of water placed in the boiler. Cooking for cleaning only, in welded-drum boilers, should be done preferably at 50 to 100 psi and should be repeated when the boiler is especially dirty with oil. For embrittlement protection in riveted type boilers, follow this cleaning procedure with another cooking at operating pressure.

In any case, if you have a company water treatment chemist or an outside water consultant, have him check your boiling-out method.

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EL CENTRO

(Continued from page 60)

duced draft fans are at grade level outdoors at the rear of the boiler, the induced draft fan discharging to a 100-ft, self-supporting, steel stack. A bay located on the opposite side of the plant from the boiler houses the oil conditioning equipment, air conditioning equipment, shop and material storage space on the basement floor; the 13,800 and 2400-v switchgear, laboratory, battery room and locker and shower room on the operating floor; and the Superintendent's and Load Dispatcher's offices on the next floor. The main and auxiliary transformers are located in an outdoor substation just beyond this bay with a transfer track and car provided to handle the transformers. A railroad spur track extends into the turbine room basement alongside the turbine foundation. Between the turbine room and boiler firing aisle there is an auxiliary bay in which are located the 2400-480-v transformers, 480-v switchgear, boiler feed pumps and service and control air compressors on the basement floor; the deaerating and low-pressure heaters and air ejectors on the operating floor; and high-pressure heater, evaporator, evaporator preheater and chemical feed pumps on a floor above.

A feature of the plant is the central control room located on the operating floor in the auxiliary bay between the initial boiler and the future boiler. As shown in the view in Fig. 1, the turbine and electrical boards are in line on the turbine side of the room and the boiler board on the boiler side of the room. All primary operating equipment is controlled from these boards on which are mounted a full complement of indicating and recording instruments and supervisory alarm systems. All boiler controls are mounted on a short bench board on the boiler board. All four boiler burners and the throttles of both main and auxiliary turbines can be seen from one end of the room. The principal operating equipment is located as close to the control room as practicable.

The condensate storage and fuel oil working tanks are located outdoors adjacent to the boiler and the main fuel oil tank is located alongside the spur track 600 ft from the present building.

In the pump house, the circulating, service, evaporator feed and raw water pumps are located in an aisle over their respective wells and are all of the vertical type which can be started remotely, without priming, from the control room in the power plant. Adequate sheltered storage for chemicals is provided and is arranged for easy unloading to storage and handling to the feeders and mixing tanks.

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loam under the site. The Imperial Valley was formerly part of the Gulf of California which was filled with silt from the Colorado River. Records indicated that loam would extend for some 1000 ft below the site. Friction piles would merely transfer settlement lower and probably would result in serious differential settlements. It was decided to distribute the concentrated loads of the equipment over a mat consisting of ribs ten feet deep with a bottom slab ten inches thick, which resulted in an average bearing pressure of 800 lb per sq ft. The ribs are located to take the heaviest concentrated loads directly, but generally they form an egg crate over the entire area. Further stiffness was added by having the basement floor slab act as top flange for the rib beams. The mat was proportioned so that the weight of the earth removed equalled the weight of the structure and equipment superposed. After a completely uniform initial settlement of about ⅝ in., which was, in part, due to a tendency of the soil to spring up when unloaded, no further settlement has been observed. Permissible soil pressures made it necessary to limit the height of the fuel oil storage tank to 20 ft and it rests on a concrete ring at its outside edge.

Rigid frame design with moment connections and knee braces was employed generally to resist seismic forces. Cross bracing was used for this purpose only in the outer shell of the building and in a few other locations where accessibility for operation and maintenance was not required.

Welded rolled sections were used to span the turbine room instead of conventional trusses. The exterior of the building consists of a six-inch concrete wall with modest architectural treatment. The turbine room floor has a scored, colored cement finish. The roof deck is of light weight gypsum slabs with a slight pitch and without parapets. The pumphouse is of similar construction.

The circulating water lines to and from the cooling tower are of 36-in. concrete pipe. The primary settling basin is gunited on both side slopes and bottom to facilitate cleaning with a suction pump or hose. The main reservoir is gunited only on the side slopes to withstand wave action.

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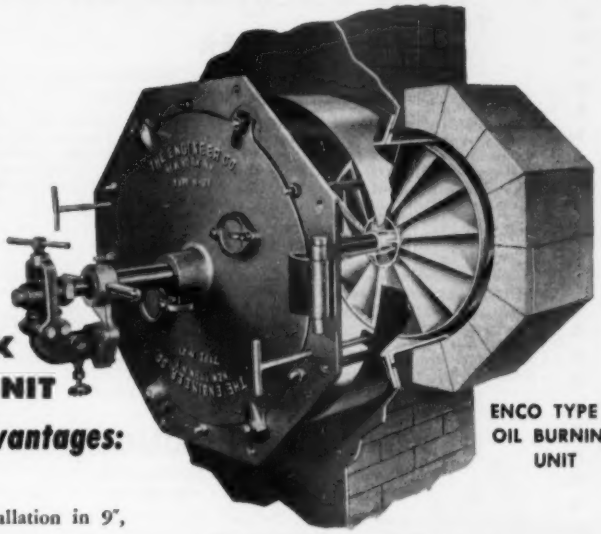

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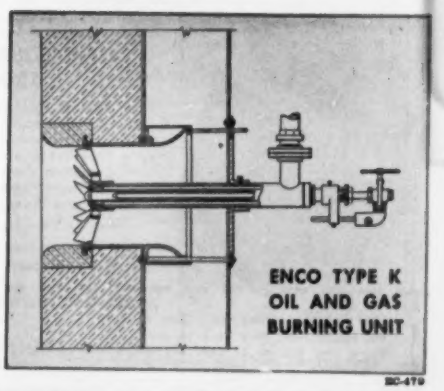

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which limits ground fault currents to approximately 127 per cent of generator rated amperes. A neutral breaker is provided to isolate the generator neutral in case of ground faults. The generator differential relays also trip the neutral breaker.

Because of the "quick pick-up" design of the plant with the auxiliary turbine-generator serving as an emergency source for the essential auxiliaries, there is no general auxiliary transformer. Therefore, in order to have switching facilities for obtaining auxiliary power from the 88 kv system when starting up the plant and during periods when the unit is shut down, a 13.8 kv generator breaker is provided. Additional flexibility is secured by the provision of a 13.8 kv breaker for the auxiliary power transformer and an isolating horn gap switch on the 13.8 kv side of the main power transformer bank. The main and auxiliary power connections are shown in Fig. 6.

The Westinghouse step-up power transformer bank consists of three single-phase, triple-rated transformers with forced-air and forced-oil cooling equipment, and are each rated at 6000 kva self-cooled, 7500 kva forced-air cooled, and 10,000 kva forced-oil and forced-air cooled. Triple rated transformers were selected because the inherently lower core loss results in better efficiency for the 2000 kw spinning reserve load contemplated than could be obtained with full-rated, self-cooled transformers. The transformer bank is connected delta on the low side and wye, with neutral solidly grounded, on the 88 kv side.

The Westinghouse auxiliary power transformer bank consists of three single-phase, self-cooled, 750 kva transformers connected delta/delta.

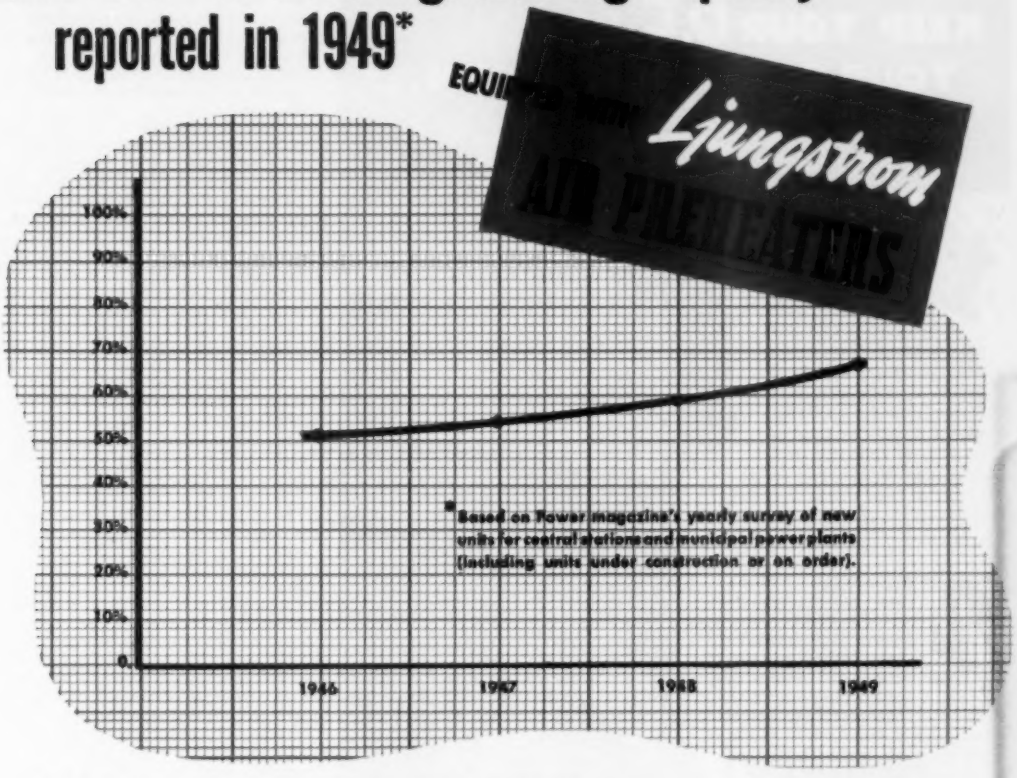
The 13.8 kv switchgear, furnished by the General Electric Co., is of the indoor, metal-clad, heavy duty type with vertical-lift, "magneblast" power circuit breakers, and includes: generator and auxiliary power transformer breakers, bus and generator potential transformers, necessary instrument current transformers for metering and relaying, and generator surge protective equipment.

The generator neutral switchgear is of the same type and rating as the main 13.8 kv switchgear so that the spare removable element provided for the main switchgear will also serve as a spare for the neutral switchgear.

The 2400 and 480-v station auxiliary buses are each divided into two sections: essential, for auxiliaries necessary for operation of the unit, and non-essential, for other auxiliaries. But tie breakers are provided to sectionalize the buses. Auxiliary motors 100 hp and larger are supplied at 2400 v and station lighting transformers and smaller motors are supplied at 480 v.

The auxiliary bus arrangement

Over 65% of steam generating capacity reported in 1949*



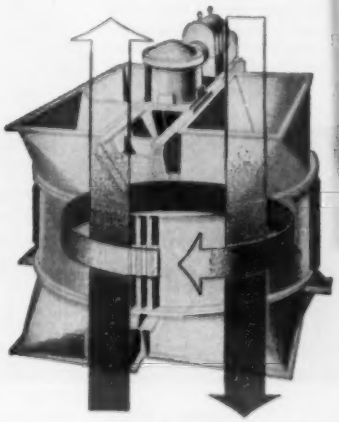
Again in 1949 utilities continued to register an increasing preference for the Ljungstrom regenerative air preheaters. Over 65% of the steam generating capacity for central stations and municipal power plants (including units under construction or on order) reported in Power magazine's 1949 Modern Plant Survey will be equipped with Ljungstrom air preheaters.

The reasons behind this wide acceptance of the Ljungstrom, the only regenerative type air preheater, are sound and simple:

1. High Heat Recovery: The Ljungstrom air preheater, by employing the continuous regenerative counterflow principle, assures the highest practical heat recovery, up to 70% of the total heat in the stack gases.

2. Low Operating Costs: The regenerative principle provides accurate control of metal temperature throughout the entire unit. This permits operation with low maintenance costs, under conditions which would cause rapid deterioration in other designs.

3. Reliability: The high availability of the Ljungstrom air preheaters with all types of boilers, under every condition of operation, is a matter of record in power plants throughout the country.



The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

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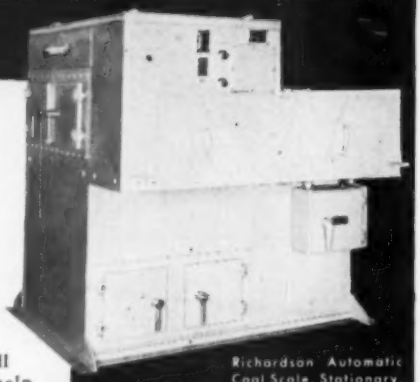

Richardson Automatic Coal Scale, Stationary, Floor Mounted Style.

1 Richardson Coal Scales—Low B. E. (boiler efficiency) and costly coal waste are quickly signalled, the moment they begin, when you install a Richardson Coal Scale over each boiler. You get a detailed record of coal consumption by the hour, shift, day, week or month. By checking on all forms of coal waste they help to keep your power costs at a minimum!

Richardson "MONORATE" Distributor showing patented curved plate which prevents separation of lumps and fines.

2 Richardson "Monorate" Distributors—Designed by Richardson engineers for preventing coal segregation in stoker fired installations, the curved top plate of the "Monorate," causes all coal, *lumps and fines*, to fall at the same rate. It eliminates the tendency for the mixture to separate. This insures a uniform spread over your stoker hopper . . . a prerequisite for efficient combustion.

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Richardson engineers will be glad to discuss your coal consumption problems. For complete details on Richardson Coal Scales write for Bulletin No. 1145. Bulletin No. 1349-P gives complete information on the "Monorate."

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6363

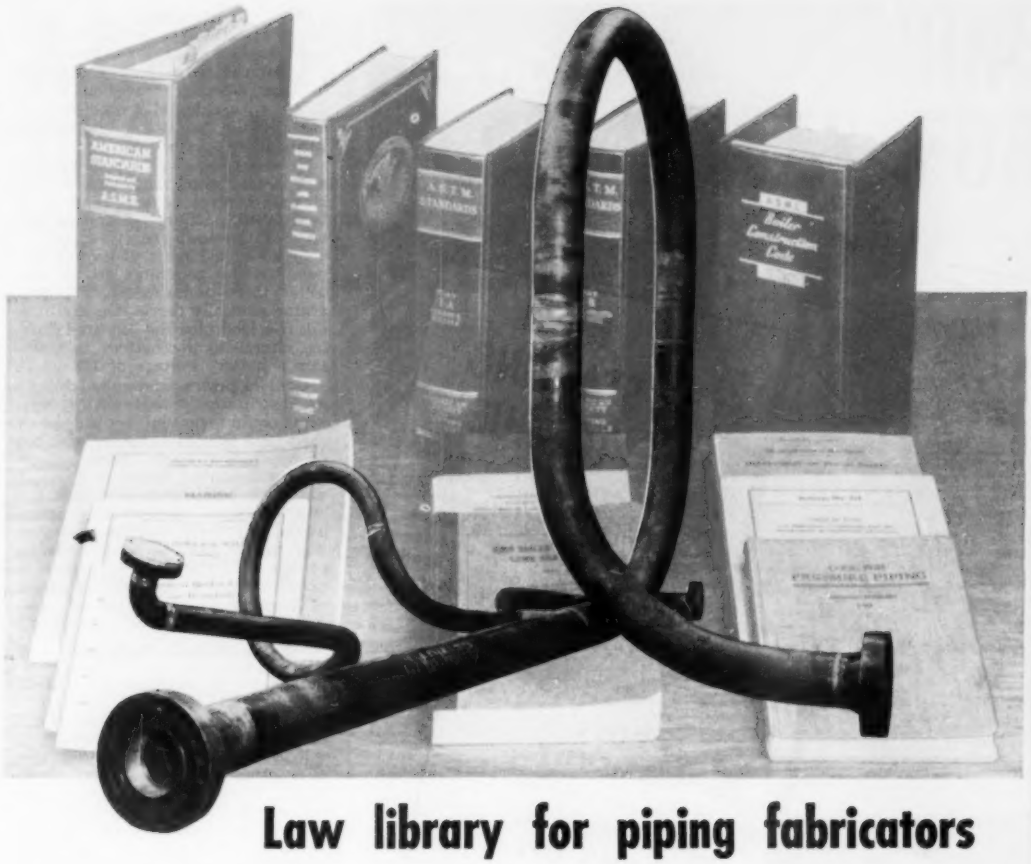
was determined by the requirement for "quick pick-up" of the essential auxiliaries by the auxiliary generator. In the event of a system disturbance of such magnitude as to endanger the station auxiliaries, voltage and frequency relays, together with the necessary auxiliary relays, are provided to automatically start the auxiliary turbine-generator, sectionalize the buses, and close the generator 2400-v breaker to pick up the essential auxiliaries. The "quick pick-up" sequence can also be activated manually from a selector-control switch on the electrical control board. A time delay of approximately one second is introduced between the opening of the bus sectionalizing breakers and the closing of the generator breaker to permit the decay of the voltage induced in the rotating induction motors and thus prevent the possibility of an out-of-phase condition between the motor and generator voltages.

The 2400-v switchgear was furnished by General Electric Company and consists of metal-clad switchgear with vertical-lift, removable "Magneblast" power circuit breakers. The unit substation load center supplying the 480-v plant auxiliaries consists of two General Electric Co. dry type, three-phase, 1200 kva, 2400/480-v transformers connected through bus ducts to a metal-enclosed, dead-front, low voltage switchgear with drawout air circuit breakers. The pump house switchgear is back-to-back arrangement of a "Cabinetrol" motor control center with a drawout switchgear section at one end similar to the low voltage switchgear in the plant and containing the incoming feeder and bus tie breakers.

Protective relays for the 2400-v motors consist of thermal relays connected to provide an alarm for sustained overloads of approximately 115 per cent of motor rating, and extra-long-time delay induction relays with instantaneous attachments connected to trip the motor breaker. The instantaneous elements provide short circuit protection while the long-time delay induction elements are set to trip the motor breaker for sustained overloads in the order of 140 to 150 per cent of motor rating. The settings of the thermal and induction relays are coordinated to provide an advance warning to the operator before the loss of an auxiliary motor from overload.

The protective relay scheme for 440-v motors individually controlled by electrically operated breakers in the 480-v switchgear is the same as for the 2400-v motors, except that thermal-magnetic relays are used instead of the long-time induction relays with instantaneous attachments.

Short circuit and overload protection for the 440-v motors controlled by magnetic-motor starters consists of either fuses or a circuit breaker,



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and thermal relays provided in the individual combination starters.

Ground alarm relays are provided in each switchgear section to indicate an accidental ground on any part of the normally ungrounded 2400 and 480-v systems.

The control power supply for circuit breaker operation and miscellaneous control devices is supplied by a 60-cell, 125-v, d-c storage battery of the lead-acid type, and is charged by a 7.5-kw, 140-v constant potential d-c generator driven by a 440-v, three-phase motor. The generator normally carries the continuous d-c load plus the required floating charge to the battery to maintain a battery voltage of 129 v.

Control power is supplied from a d-c distribution panel to each switchgear equipment and control board through a pair of cable feeders, one of which is a spare. Each switchgear and control board is provided with two 2-pole non-automatic circuit breakers mechanically interlocked to prevent simultaneous closing, which also serve as selector switches for the two d-c feeders to provide a quick and positive means of transfer in the event of cable failure.

Miscellaneous Equipment

Fuel oil is received by gravity from trucks or tank cars into a 20,000-gal underground concrete receiving tank and pumped either to a 15,000-bbl welded steel storage tank or a 20,000 gal working tank at the plant. Main oil pumps are of the screw type. Oil is heated in three 650 psi oil heaters, two normally being in series and one spare, with steel tubes and without floating heads. Both heads are removable for cleaning.

The main steam lead is of carbon molybdenum composition because of high temperatures during quick pick-up. A stop valve is provided near the boiler for hydrostatic test and additional turbine protection.

Service water is supplied from either the circulating water system or from the clarified, or raw water, at the pumphouse. Treated service water is returned to the circulating system.

The turbine room crane has a capacity of 35 tons, which provides for handling some of the system's larger transformers. Turbine oil is conditioned by a Bowser continuous bypass filter system.

The Superintendent's office, Load Dispatcher's office and the laboratory are air conditioned from a York central system through distributing ducts. Refrigerant is circulated to Trane coolers for conditioning the control room. The plant building is ventilated and cooled by four American Blower capillary coolers having an aggregate capacity to bring 211,200 cfm of air to within 2.1 F of the wet bulb. Warm air is dis-

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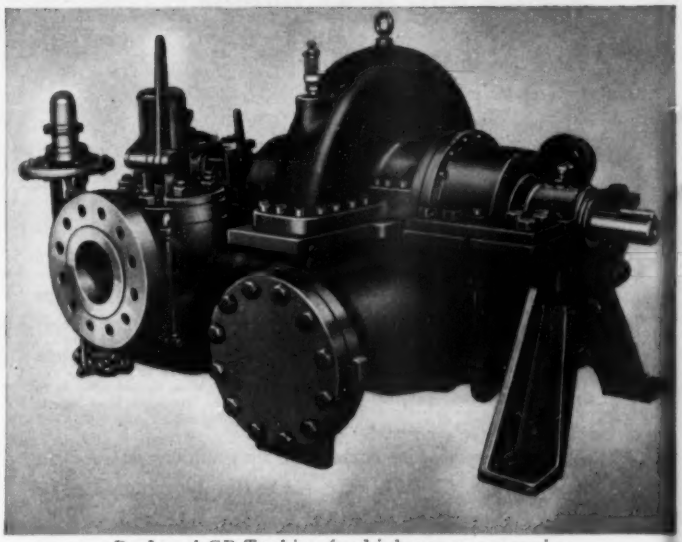

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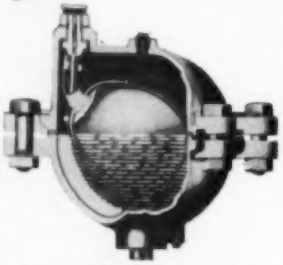

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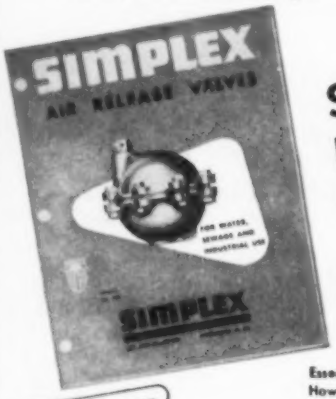

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charged through heat valves in the turbine roof.

The operating force has been organized with a total of 15 men for the first unit. The unit was synchronized seventeen months after ground was broken for construction. Only minor difficulties were encountered in the initial operation. Present load conditions preclude quick pick-up tests until a later date.

The project was carried out under the immediate direction of Mr. B. A. Weiss, Executive Engineer of the Imperial Irrigation District. Gibbs & Hill, Inc., Engineers, New York and Los Angeles, executed the design and supervised the construction. Dames and Moore were consultants on the subsoil and substructure.

ENTROPY-BALANCE DIAGRAM

(Continued from page 67)

diagram. This table is an illustration of the type of over-all picture of power-plant losses which may be prepared relatively quickly by means of the entropy-balance diagram.

Table 1 shows the losses associated with feedwater heating, while many readers are accustomed to think of gains from feedwater heating. This difference is only a matter of viewpoint. Feedwater heating results in an efficiency gain relative to the Rankine cycle without feedwater heating. On the other hand, an actual feedwater-heating installation always results in a loss relative to the perfect regenerative feedwater-heating cycle. This latter is the viewpoint in this paper.

Derivation of Table 1 is explained in the paper.

The two asterisked entries require special explanation. The turbine-shaft power output of 11,940 kw has a heat equivalent of 40,748,235 Btu per hr. At 551.41 F abs temperature, this amount of heat flow would have an entropy flow equivalent of 73,898.3 Btu/deg F/hr. This number has been included in Table 1 as the first asterisked quantity.

The 217,377.5 Btu/deg F/hr entropy increase shown as the boiler output in Table 1 was calculated as follows: Fig. 1 shows a boiler output of 119,864,000 Btu per hr. At 551.41 F abs temperature, this amount of heat flow is equivalent to 217,377.5 Btu/deg F/hr. This quantity represents the entropy equivalent at condenser temperature of the boiler heat output.

Column C shows the power output loss corresponding to each entropy increase. These were calculated by the formula

$$\text{Kw loss} = \frac{\left[\begin{array}{c}\text{Hourly entropy increase} \\ \text{Btu/deg F/hr}\end{array}\right] \times \left[\begin{array}{c}\text{temperature at condenser,} \\ \text{deg F abs}\end{array}\right]}{3412.75} \quad \ldots\ldots(2)$$

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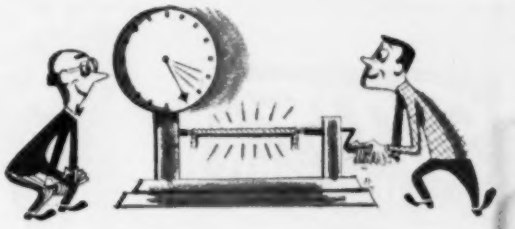

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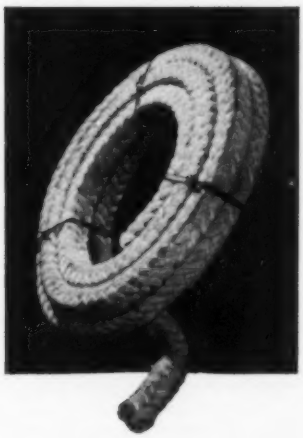

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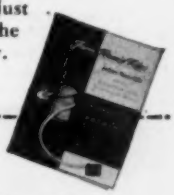

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PG-5

Column D shows the percentage ratio of each individual loss to the turbine output and column E shows the percentage ratio of each loss to the boiler output.

The values in column C may be used to "capitalize" each of the individual losses. Again, using the No. 2 heater steam-extraction pipe as an example, if 1 kw of extra power output at constant input is worth, say, $100, then a capital expenditure of $980 would be justified to eliminate completely the pressure drop in this pipe, or a capital expenditure of about $500 to decrease the pressure drop from 10 to 5 per cent.

Feedwater-Heating-Cycle Losses

A graph shows the cumulative loss in the feedwater-heating cycle as a function of the feedwater temperature. This shows that a perfect feedwater-heating system would improve the over-all plant efficiency (at constant boiler efficiency) by about 6 per cent.

This graph, not shown here, indicates the portion of the loss in the feedwater-heating cycle that is caused by superheat in the extracted steam. It shows that the loss from this source amounts to about 0.2 per cent at the 338 F feedwater temperature leaving the No. 4 heater.

To calculate the point at the 489 F boiler saturation temperature, a fictitious stage of feedwater-heating was assumed which delivers saturated water to the boiler at 614.7 psia pressure, heated by steam extracted from the turbine throttle. With this imaginary feedwater heater in the picture, the entire feedwater-heating system from hot well to boiler saturation temperature extracts 4244.5 Btu/deg F/hr less entropy from the turbine than it adds to the feedwater. This 4244.5 Btu/deg F/hr value represents the saving which could be made if a perfect feedwater-heating system were available which delivered saturated water to the boiler.

Reheat Effects

The entropy-balance diagram is strictly correct for showing where cycle losses actually take place; however, it gives slightly conservative values when used to evaluate the gains which would be made if losses were eliminated or reduced. As an example, the No. 2 heater extraction pipe is analyzed in detail in the complete paper.

If a turbine were 100 per cent efficient relative to the Rankine cycle and had an isentropic expansion line, all reheat factors would be 1.00. Since all large turbines have Rankine-cycle efficiencies between 80 and 90 per cent, the reheat factors can never get appreciably above 1.00. About 1.10 to 1.15 is the highest reheat factor that will be encountered in any normal installation; thus considering it as unity will cause no great error in perspective for a given study.

Simplified Calculation Methods

Equation for a throttling process is given in the paper, also a table showing the actual increase of specific entropy associated with the 10 per cent pressure drop in each of the four extraction pipes of Figs. 1 and 2, together with the values calculated by the equation, which check closely.

Simple procedures also can be worked up for estimating quickly the entropy increases associated with heater terminal-temperature differences, and the like, without reference to a steam table.

Although a sizable amount of calculation work is required to make a complete analysis of a given installation, any one question may be answered quite quickly after a heat balance is available. Preliminary estimates of many losses also may be made prior to a heat-balance calculation by making judicious assumptions as to the mass flows involved.

The entropy-balance diagram is not a substitute for other methods of analysis. It is another way of looking at a problem which should be used when it is helpful and not used when other methods seem more straightforward to apply.

Don't let slime steal the efficiency of your surface condensers and heat exchangers. Put Builders Chlorinizers to work and you're assured of the exact chlorination for slime prevention. Chlorinizers are easy to install, easy to run, and easy to maintain. Operation is extremely simple: Just set the chlorine feed rate and you can see the actual delivery on the positive, direct-reading Sightflo indicator. It's as simple as that. Chlorinizers are ideal for intermittent operation. They maintain their vacuum during shut-down periods. Feeding starts instantly at every dosage period. For Bulletins and engineering information, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 385 Harris Ave., Providence 1, R. I.

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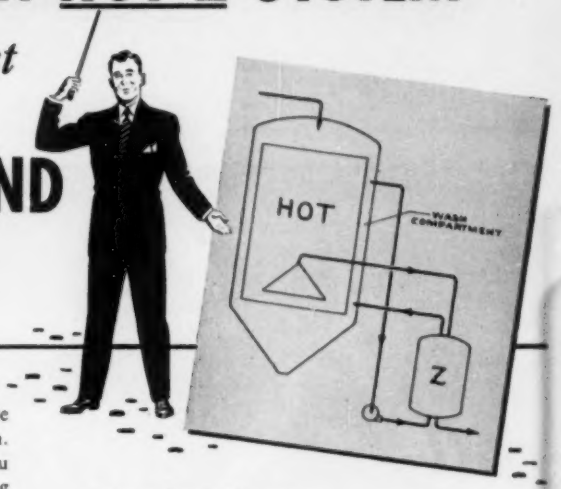

Choosing between Hot Process and Zeolite is no longer a boiler feed water problem. The Worthington Hot-Z System gives you the advantages of each system including deaeration.

SEE WHAT HOT-Z DOES FOR YOU:

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10. Reduces phosphate precipitates in boiler to unobjectionable amount.
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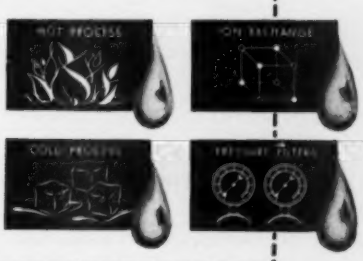
INVESTIGATE! If you are now considering split treatment, hold up your decision until you examine the Worthington Hot-Z System. Tell us your conditions of service and get our recommendation in terms of dollars and benefits. You'll find in our Hot-Z System, as in so much other equipment, *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Water Treating Division, Dunellen, N. J.*

30-8

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



HELPFUL BULLETINS

(Continued from page 36)

explained and illustrated. Includes dimensional data on single and two-pass types for screw and flanged connections. Rose Heater & Mfg. Co., Inc.

129 Aluminum Heat Exchanger Tubes—Engineering and application data covering manufacturer's aluminum heat exchanger tubes is given in 24-pp Bulletin AD-186. Fully illustrated with photos, it presents performance and cost advantages of the tubes, explains their fabrications, the effect of cooling water, inhibitors, cathodic protection. Also discusses aluminum alloys used and the special advantages of each, and the use of aluminum alloys in shells and headers, tube sheets, baffles and support plates and flanges. The applications of aluminum tubes in several industries are given. Also included are fluid flow and heat transfer characteristics, estimating data, allowable internal working pressures, nominal composition of wrought aluminum alloys and list of standard warehouse items. Aluminum Co. of America.

WATER TESTING AND SOFTENING

130 Water Clarification and Softening—Twelve-pp Bulletin WC-103 on water clarifiers and cold process softeners describes the design, operation and features of manufacturer's unit of this type, with explanations in tabular form. Introductory sections explain principles of chemistry of cold process water treatment, and compare company's reactivating equipment with other methods of water purification. Various accessories are also described, and bulletin is illustrated with diagrams and installation photos. Graver Water Conditioning Co.

131 Water Hardness Test—Two-pp Bulletin 28X7446 explains company's simplified method of determining total hardness in water, discussing methods practicability and accuracy. Tells reagents used, procedure and principle of method. Three-step procedure and test kit are illustrated. Allis-Chalmers Mfg. Co.

OTHER EQUIPMENT

132 Compressed Air Handbook—This 16-pp booklet, prepared by organization's committee on engineering education, presents a brief discussion of compressed air as an important form of power, showing the application of compressed air and gas theory to actual machines and uses. It outlines how air is compressed, machines employed in compressing air and gas, and basic principles of the utilization of air power. Illustrated with photos and sketches, its main sections are devoted to the uses and theory of compressed air and types of compressors. Although written primarily for engineering students, it contains much of interest for the engineer whose work involves the supervision of compressed air lines and equipment. Compressed Air and Gas Institute.

133 Fuel Oil Conditioning — Bulletin 2/10/48 RCU is a 6-pp illustrated technical discussion on fuel oil treatment and sludge removing. Lists chief problems that develop in the operation of oil burning equipment, tells what causes these problems and how they may be eliminated by company's treatment and sludge remover. Covers usage and dosage in connection with various equipment and stresses advantages of the product. E. F. Drew & Co., Inc.

134 Refractory Concrete Handbook—Latest information on company's refractory and heat-resistant concrete is given in this revised 24-pp booklet, a manual of how-to-do-it information. Detailed data on refractory concrete mixes—proportions of company's Lumnite and various aggregates—is given. From tables contained in this publication you can select proper types of refractory concrete for a wide range of temperatures and insulating conditions. Illustrated with photos of many kinds of installations, precast shapes available. Lumnite Div., Universal Atlas Cement Co.

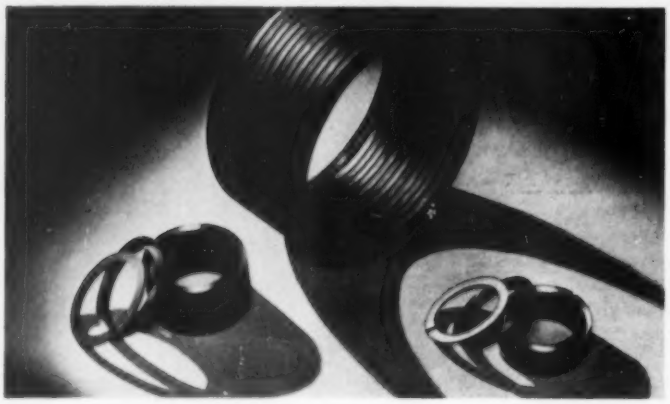
135 Oil Seals and How to Use Them—Bulletin PE-46A is a 16-pp handbook of useful data for engineers needing information on oil seals. Photos show where to use the seals and how to install them. Drawings illustrate how the lip and heel construction of these non-metallic oil seals can be varied. The text gives other pertinent information of importance to engineers and maintenance men. Booklet is divided into sections on the principle of company's seals, their construction, advantages in various applications, installation data and other information. Johns-Manville.

136 Fly Ash Collector—This 8-pp bulletin introduces a new type of low resistance collector designed for efficient fly-ash prevention on small boiler installations of limited draft. Includes photos of unit, graphs showing efficiency and draft loss, size selection table and dimensional data. Discusses operating features of collector and illustrates typical installation arrangements. Buell Engineering Co., Inc.

137 Iron Cement Handbook — This pocket-sized 40-pp catalog on company's iron cements for repair work and other applications is filled with valuable suggestions for power engineers. It discusses 10 different products and gives general tips on mixing and applying them. More important, it provides illustrated instructions for dozens of repair and maintenance jobs, including stopping leaks on steam boilers, strengthening corroded tank surfaces, reinforcing pipes, making flanged joints, stopping leaks in concrete. Smooth-On Mfg. Co.

138 Concrete Flooring—How a heavy-duty industrial flooring is intended to meet production needs and solve special problems is explained in Bulletin 601. Stresses durability of this emery aggregate concrete flooring, citing tests results and listing its many advantages. Twelve installations are pictured. Walter Maguire Co., Inc.

139 Oil Purification—Here's a 4-pp illustrated bulletin describing the purification, dehydration and degasification action of manufacturer's new portable



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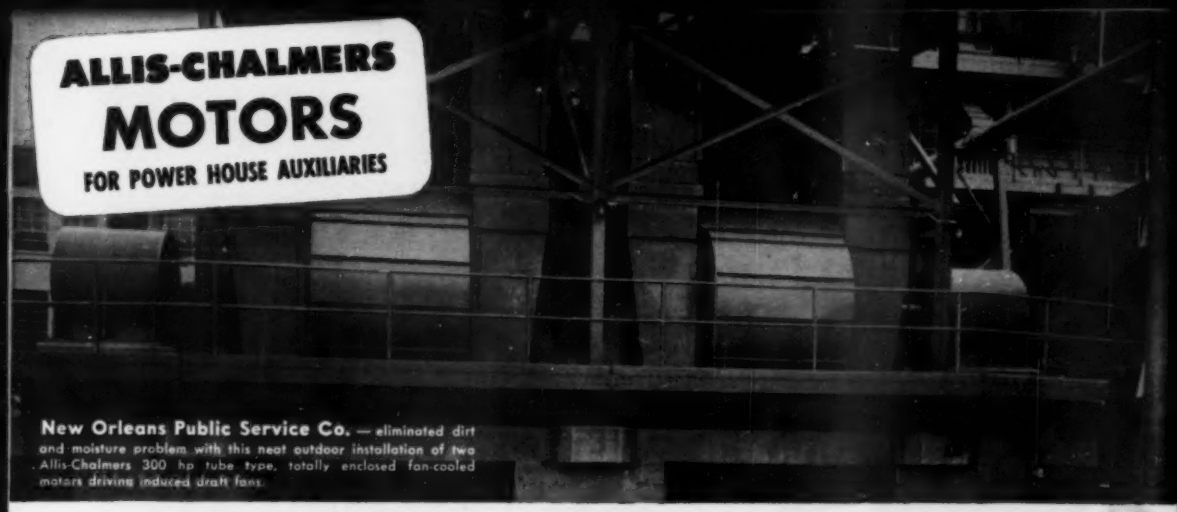
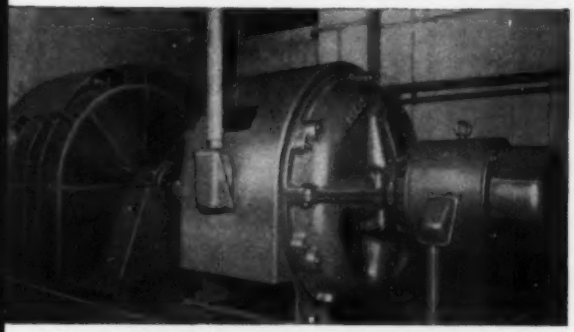


ALLIS-CHALMERS
MOTORS
FOR POWER HOUSE AUXILIARIES

New Orleans Public Service Co. — eliminated dirt and moisture problem with this neat outdoor installation of two Allis-Chalmers 300 hp tube type, totally enclosed fan-cooled motors driving induced draft fans.

Motor Reliability For Toughest Jobs!



Potomac Electric Power Co. — drives induced draft fan through an electric coupling with this 400 hp drip-proof Allis-Chalmers motor.

HERE ARE REASONS why utilities like these all over the country are using Allis-Chalmers motors for their auxiliary drives.

First, motors are furnished in every needed type and size. In addition, each motor has features to assure the reliability that power plants need. For example: two pole motors have a pressure vent arrangement in the bearings to prevent oil leakage into the stator in spite of the high speed of the motor.

The tube type, totally enclosed fan-cooled motor has straight heat exchange tubes which are self cleaning under practically all conditions and make the motor ideal for outdoor locations.

Extra varnish treatment is provided in all power house motors to resist moisture and acids — assure long life.

Allis-Chalmers is equipped to build the complete motor-pump-control package. If you intend to modernize or enlarge your facilities, it will pay you to specify Allis-Chalmers. Call your nearby A-C Sales Office for further information.

A-5084

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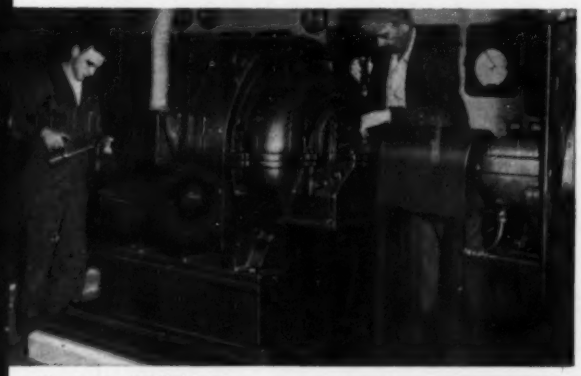


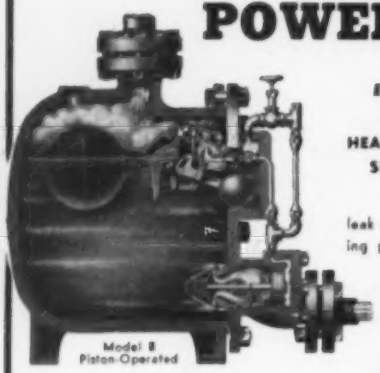
Kentucky Utilities Co. — uses two of these highly reliable Allis-Chalmers 700 hp two pole motors to drive high pressure boiler feed pumps.

Toledo Edison Co. — drives condenser pumps with these two 400 hp vertical cage motors.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Nicholson Super-Trap for
POWER SERVICE



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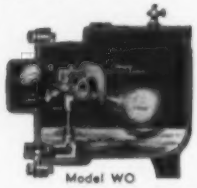
leak even if cooked dry; rugged; working parts of stainless steel. Pressures, 2 to 650 lbs. The lowest price large capacity trap.



Model WO

Thousands of installations attest to the enormous drainage capacity of this Nicholson trap. Piston-operated and with valve orifices up to 2" diam., it discharges large volumes of water almost instantly. Other features: won't

NICHOLSON WEIGHT-OPERATED TRAPS—Three models for pressures to 200, 650 and 1500 lbs.; for steam, air, gasoline. Also feature large capacity and proof against leaking.

Catalog 250 or see Sweet's

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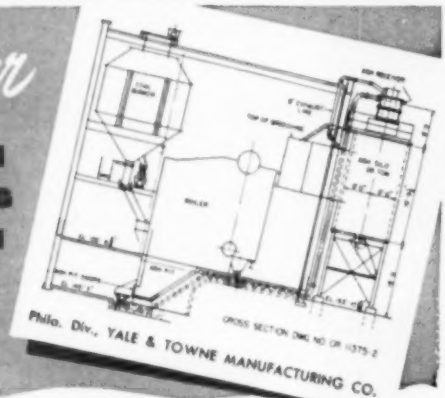
Another
COAL and ASH HANDLING INSTALLATION by BEAUMONT



Here's one of the many efficient coal and ash handling installations—designed, manufactured, installed by Beaumont. The above system is operating at the Philadelphia plant of Yale & Towne Manufacturing Company. This plant saved both time and expense—through one-contract-economy . . But you're right! It's up to us to convince you of the advantages in a Beaumont installation: So let us send you our folder of typical installations. Write to:

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DESIGNERS—MANUFACTURERS—ERECTORS BULK MATERIAL HANDLING SYSTEMS

"Purivac" on oxidized insulating oils in transformers and circuit breakers. Details of this purifier, designed for companies or utilities having smaller amounts of insulating oil to purify, are explained. Honan-Crane Corp.

140 Spreader Stoker—Bulletin 880, 40 pp, describes a spreader stoker with overthrow rotor designed to provide uniform fuel distribution. Discusses advantages of this type of stoker, including its efficiency in the burning of certain kinds of coal and in the handling of fluctuating loads. Power-operated and hand-operated dumping grates and stationary grates are described and illustrated by photos and drawings. Book also includes photos of more than 40 typical installations. Detroit Stoker Co.

CATALOG LIBRARY

(Continued from page 52)

and snatch blocks, as well as drum type car pullers for heavy duty service. Link-Belt Co.

276 Welding Fittings and Flanges—Titled "Catalog and Engineering Data Book 211," this handsomely bound 262-pp manual provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical, illustrated information covering welding fittings and flanges under varying conditions of temperature and pressure, location and materials processed. Discusses their use in different types of piping systems.

A section is devoted to welding fittings and flanges in special metals and alloys and their specific applications. The technical section covers properties of pipe, rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids.

Distribution of this excellent piece of industrial literature is limited to major users, designers and erectors of industrial piping. (Please include your title when requesting it.) Names of those who receive copies will be registered for company's supplemental data and literature. Tube Turns, Inc.

277 Transmission Belting—Catalog M-9922, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings showing types of transmission drives. United States Rubber Co.

278 Steels for Hot Spots—This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels; and illustrated description of major high temperature testing facilities in the United States, and a comprehensive bibliography of company's technical publications on the properties and use of steel at high temperatures. United States Steel.

279 Fluid Reduction Mills—Bulletin 430-1, 8-pp, introducing company's fluid energy reduction mill, discusses the advantages of finer particle size in many processing operations. Illustrates the mill and explains its grinding operation. C. H. Wheeler Mfg. Co.

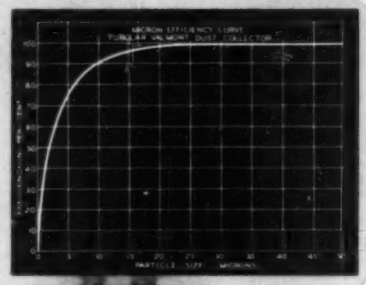
280 Technical Data on Plexiglas—This is a file folder of technical and application information on Plexiglas sheets, rods and molding powders, covering their workability, physical properties, available thicknesses. Includes data sheets on the uses and advantages of Plexiglas in large area lighting, typical designs of coffers, photos of installation and a discussion of room lighting. Rohm & Haas Co.

281 Wired Television—Illustrated Bulletin 1025, 16 pp, introduces company's Utiliscope, a camera and monitor type of equipment designed to enable an observer to see where he can't look. Some of the many applications for this wired television which are described and illustrated include viewing instrument readings at remote points, checking boiler water levels, watching coal flow in chutes, watching hazardous laboratory tests, checking furnace ignition. Also shows the use of several sets in scheduling of assembly work. Diamond Power Specialty Corp.

THE VALMONT TYPE S COLLECTOR

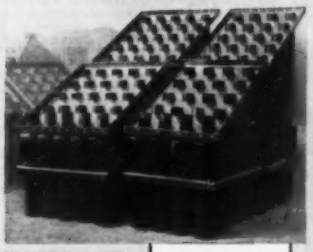
CATALOG DIGEST

The following information is taken from the New Bulletin on P-D Valmont Type S Collector. For Complete Bulletin containing dimension tables, sizes, nomographs and suggested installation plans, write our Project and Sales Engineers.

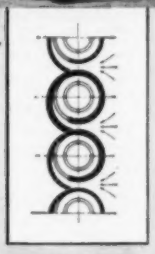


P-D EFFICIENCY CURVE

VALMONT TYPE S TUBES SHOWING FLOW OF GASES AND INLET



HORIZONTAL TYPE TUBE SHEET SECTIONS KNOWN AS "UNI-BLOCS"



METHOD OF NESTING TUBES—REDUCES TURBULENCE . . . SAVES SPACE

HIGH EFFICIENCY—The outstanding contribution to higher efficiency in the P-D Valmont Type S is the inlet slot design. A patented development of Prat-Daniel, this inlet is high and narrow, reducing the radial distance of dust-travel. To explain its effect on dust collection, we quote from Cyclone Dust Collector Design, by Melvin W. First, Paper No. 49-A-127, presented at the Annual Meeting of the American Society of Mechanical Engineers, Nov. 27—Dec. 2, 1949, page 14.

> "Entry width is an important variable in cyclone efficiency, as it controls the stream width. This, in turn, directly controls the radial distance particles must traverse to reach the cyclone wall and be separated by centrifugal force. The smaller the radial distance to be traversed, the lower the tangential velocity needed (less energy loss) and the smaller the particle that can be successfully separated for a given flow rate."

LONG LIFE—Extensive tests were made to determine the wear factor. All types of abrasive dusts were run at accelerated speeds, against various metals simultaneously and steel proved to be the most resistant to erosion.

Another long life factor is the lower velocity required due to the small tube diameter. It is a well-known fact that reduction of tube diameter produces higher centrifugal force. Thus, efficiencies are maintained at the lower load ranges.

MASS PRODUCTION METHODS—The P-D method of "uni-bloc" construction permits manufacture and assembly of sub-sections at the factory. These are shipped to the field and easily erected, either vertically or horizontally, to fit the layout. Savings in cost of erection are thus realized yet the collector is "tailor assembled" to fit the installation requirements.

SMALL SPACE FACTOR—Because of close nesting of tubes possible in P-D Valmont Type S Collectors, the space required for this apparatus is much less than conventional collectors. In many cases, P-D units have been fitted into spaces that could accommodate no other type.

The Thermix Corporation, our Sales and Project Engineers are specialists in the art of dust collection. Consult them about your dust problems.

Project and Sales Engineers

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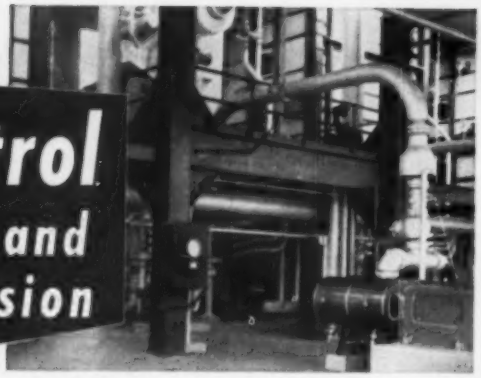

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Recent ENGINEERING BOOKS

Chemical Engineers' Handbook; New 3rd Edition; by a Staff of Specialists; John H. Perry, Editor; 1884 pages, illustrated; 7¼ by 9¾ in.; flexible cloth binding, published by McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 18. Price $15.00.

This new 3rd edition of this handbook provides a virtually complete revision of what is considered the standard chemical engineering reference work, including a fresh and comprehensive coverage of both standard and recently compiled facts, figures, and methods applicable to both chemical engineering and its related fields.

An authoritative group of more than 140 recognized specialists have contributed detailed explanations of new developments in every branch of the industry—including those of recent critical years—to bring the Handbook up to date on currently-approved technical data, new procedures, new equipment, etc. Important information previously restricted to "classified" listing, is included for the first time.

In addition to many expanded and wholly revised chapters—and several almost completely rewritten major sections—the new 3rd edition of the Handbook features several entirely new sections. These provide important information pertaining to Furnaces and Kilns, Size Enlargement, General Theory of Diffusional Operations . . . Azeotropic, Multi-component, Extractive and Molecular Distillation and Dialysis.

Other improvements included in the revised editon are: (1) an increased coverage and new treatment of low-temperature refrigeration and processes; methods of mechanical separations; and sublimation (2) extensively revised material on flow of fluids; heat transmission; solvent extraction; mixing; absorption; physical and chemical principles (3) new presentation of humidification; dehumidification; spray ponds and cooling towers; mathematics; mathematical tables and weights and measures (4) a thorough revision of material on fuels; eletrochemistry; refrigeration; electricity and electrical engineering; materials of construction; mechanical separations; safety and fire protection; accounting and cost finding (5) greatly expanded material on size reduction; power generation; process control; high pressure technique; plant location; gas absorption; movement and storage of materials.

More than 2000 charts, diagrams, cross-sections, flow sheets, etc. are included, and all drawings have been newly prepared and increased in size to present every detail more clearly—for more accurate reading and extra clarity. All subject matter is arranged in 2 columns for greater legibility. An extensive index makes use of more common words and includes their synonyms and equivalents.

The Chemical Engineers' Handbook, 3rd edition, offers the most complete, up-to-date, and dependable coverage of all fields of chemical engineering now available in a single volume.

• • •

Symposium on Effects of Low Temperatures on the Properties of Materials; Special Technical Publication No. 78; 68 pages, illustrated; size 6x9 in.; paper binding; published by American Society for Testing Materials, 1916 Race Street, Philadelphia, Penna. Price $1.50.

This Symposium, originally presented at a meeting of the Philadelphia District of the American Society for Testing Materials in March 1946, and reviewed by the authors in October 1949, has just become available in printed form and covers specifically the fields of both ferrous and non-ferrous metals, plastics, and rubbers. Much interest is focused on this subject because of problems in refrigeration, the chemical processes, etc. The purpose of this Symposium is to bring together some of the existing facts, data, and experience, and to suggest what might be worked for in the future.

Following an Introduction by A. O. Schaefer, the publication includes four profusely illustrated papers: Low Temperature Behavior of Organic Plastics—H. K. Nason, T. S. Carswell, and C. H. Adams; Low Temperature Properties of Elastomers—John W. Liska; Effects of Subatmospheric Temperatures on the Proper-

ties of Non-Ferrous Metals—Norman L. Mochel; The Properties of Weldments at Low Temperatures—Robert D. Stout.

• • •

Welding Metallurgy, Iron and Steel, by O. H. Henry and G. E. Claussen, revised by G. E. Linnert, Second Edition, 8¼ by 7¾ in., 505 pages, cloth, published by The American Welding Society, 33 W. 39th St., New York, N. Y. 1949. Price $2.50.

The second edition of this book involves extensive rearrangement of the material in Henry and Claussen's original publication. During the past eight years since this book was first published, great strides have been made in the art of welding, particularly in connection with the war effort. During this critical period all of the American Welding Society's efforts—research, design, production, etc.—were carried on at an abnormally accelerated pace. It is for this reason that a revision of this book at this time is extremely important. Much of our late progress in welding can be attributed to our increasing knowledge of the metallurgy of welding. It would be sheer folly to weld alloys like the high-strength heat-resisting steels or the age-hardening aluminum alloys if their metallurgical characteristics were not known.

In general pattern, the second edition of Welding Metallurgy remains unchanged. In its preparation the information which has been garnered on welding metals during the intervening years has been sifted and that which rightfully belongs in a text on this subject has been included as new material. As before, steels or ferrous alloys are the center of most discussions.

A word about the authors. Mr. Henry is Professor of Metallurgical Engineering at the Polytechnic Institute of Brooklyn and Mr. Clausen, who was formerly Adjunct Professor of Metallurgy at the Polytechnic Institute of Brooklyn, is now Metallurgist at Reid-Avery Co. at Baltimore, Maryland. Mr. Linnert, who revised this book, is Senior Research Engineer at the Armco Steel Corp. at Baltimore, Maryland.

• • •

Industrial Chemistry, An Elementary Treatise for the Student and General Reader, by Emil Raymond Riegel. Fifth Edition, 6½ by 9¼ in., 1015 pages, illustrated, cloth, published by Reinhold Publishing Corp., 330 W. 42nd St., New York, N. Y., 1949. Price $7.00.

This is the fifth edition of this famous book. Although it deals with the general subject of chemistry, it should be of interest to engineers of various types, including those in the power industry. Many power engineers, aside from their primary interest in the chemistry of feedwater and fuels, are interested in certain industrial processes and this book gives a description of many of the more common industrial processes in a way which even a layman can readily understand. The author's fundamental purpose is to give a picture of an industry, process or installation such as one might take away after a personal visit in which all operations are studied from basic chemical reactions to finished products. To this nucleus there is added a broader description of each.

The new edition has been largely rewritten, expanded and brought up to date. New material, not represented in the previous edition, includes anti-biotics, the new organic insecticides and fungicides, the utilization of wood, novel methods of the application of dyes to fiber, atomic energy and recent developments in plastics and petroleum.

The book should serve as a valuable reference book for chemical technologists and specialists, who will need it to learn what is going on in other broad chemical fields where ready access to new and outstanding developments is needed. Almost everybody should be interested in this fine book.

• • •

Electrical Machinery by Fred A. Annett. Third Edition, 6½ by 9¼ in., 458 pages, illustrated, cloth, published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y., 1950. Price $3.75.

During the 12 years since the second edition of Mr. Annett's book was published, there have been great advances in the field of industrial electronics. Because of the huge strides made in this field, this revised third edition includes a great deal of specific material on electron tubes and the circuits in which they are used. This electronic material is covered in four new chapters in the book.

In general the book follows the same

WON'T STICK
WON'T JAM
WON'T FREEZE

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pattern as in the first and second editions. There the object was to present the elementary laws of magnetism and electricity in a practical way. This was done by associating them with the problems that electricians and operating engineers deal with in their daily work so as to show how theory fits into practice. In this new edition these original basic ideas have been retained. The book covers, step by step, the installation, operation and maintenance of electrical machinery. Starting with magnetism, the properties of permanent and electro magnets, and electric circuits, it goes on to discuss the application of these fundamentals, showing how theory fits into practice. It explains how electrical instruments are constructed, how meters operate and how meters are used to make measurements. It analyzes the principles of dynamo-electric machinery and treats the different types of d-c and a-c motors and generators.

In connection with the chapters on electronics, emphasis is on such timely applications as changing alternating current to direct current, operation of adjustable speed d-c motors from a-c circuits, and smoke-density and flame-failure devices. Changing alternating current to direct current is a major application for electron tubes. Such tubes range from thimble-size, good for a few micro-amperes, to great mercury-pool-cathode designs that supply thousands of amperes. These applications are among those that industrial and power engineers come in contact with most frequently.

This is a very practical book and it should be of particular interest to practical engineers in the power industry.

• • •

Heating, Ventilating, and Air Conditioning Fundamentals, by William H. Severns and Julian R. Fellows. Second Edition, 6¼ by 9¼ in., 665 pages, illustrated, cloth, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y., 1949. Price $6.50.

As explained in the preface, the purpose of this book remains the same as that of the first edition—that is, to present the essential fundamentals of heating, ventilating, and air conditioning. Methods of application and the equipment available have changed during the past few years. Many investigations and much research are in progress. Every effort was made to include, at the time of the book's preparation, all available authentic data which are readily applicable to heating and ventilating practice.

This book is primarily intended for engineers, architects and heating contractors, but it is also well adapted for use by students of architecture and architectural and mechanical engineering. Along with the applicable theory, the accepted commercial practices are given. Examples of typical calculations have been included where they add clarity to the treatment. Representative commercial equipment has been illustrated and described. Sufficient data are given also to permit the reader to do some practice work.

The authors are well qualified to present this book. William H. Severns is professory of Mechanical Engineering at the University of Illinois, and so is the co-author, Julian R. Fellows. Mr. Severns has spent practically his whole career as a teacher but has also served as consultant on heating and air conditioning problems. Mr. Fellows has been active in both industrial and academic fields. After his graduation in mechanical engineering from the University of Michigan, his early professional experience was gained in plant engineering and production for the Hudson Motor Co., The Packard Motor Co. and the Chrysler Corp.

• • •

Steam Power Plants, by Philip J. Potter. First Edition, 6½ by 9¼ in., 407 pages, illustrated, published by the Ronald Press Co., 15 E. 26th St., New York, N. Y., 1949. Price $6.50.

This new book on Steam Power Plants is particularly designed to give young engineering graduates a thorough ground work in the fundamentals necessary in the design of steam power plants.

Because of the author's aim to present fundamentals, no attempt has been made to illustrate all of the various designs of equipment that are available on the market, nor to compare similar designs of competitor manufacturers. After a student has mastered basic principles, the author believes that he can readily learn trade differences during the early years of his industrial career. For this same reason, descriptions of equipment have been kept to a minimum and discussions of empirically designed apparatus, such as coal and ash handling systems, have been omitted. The author, who is a professor at the University of North Dakota, knows from practical experience that the principles involved in the design of the small power plant and the industrial plant are the same as for the large central station. Hence, any student who understands the equipment and methods used in large central station design should have no trouble with the design of a smaller plant. However, as Mr. Potter points out in the preface, the reverse is not true, since the small plant may not include all of the equipment used in the larger station. The design of the small plant also may be less rigorous.

While the book is designed primarily for students, it is certain that engineers in industry will also find this text very valuable and useful. The subject matter included is of the junior and senior level. There is ample material for a course lasting two semesters with three hours of recitation per week. Ample problems have been included so that the text may be used for several years without repetition of problem assignments.

Many practicing engineers have complained that they had little or no college training in making plant layouts. Therefore two design problems that have been found suitable for class purposes are included in the Appendix together with equipment dimensions.

On the whole, this is a very readable and useful book and it should be of interest to a wide variety of men in the power industry.

• • •

Steam and Gas Turbines, by Bernhardt G. A. Skrotzki and William A. Vopat. First Edition; 395 pages, illustrated; 6½ by 9 in.; cloth binding; published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Price $5.00.

Anybody who visits even a few power plants will be impressed by the great number of steam turbines in use today and the wide variety of forms they take, as the authors so rightly point out. They vary in rating from less than 1 horsepower to over 200,000 kw, they are built to operate on steam from less than atmospheric pressure to over 2400 psi and they can run at variable speeds as well as speeds varying by no more than 0.1 per cent from a specified constant speed. Steam turbines are very versatile and this has made their acceptance well-nigh universal for the production of stationary power by fuels.

There is a need for technical information at a fundamental level on the part of operators of turbines and others interested in them, and this book is designed to meet that need. It is based on special sections previously published in *Power*, greatly amplified and with much new material added.

The theme of the book is turbine behavior as applied to stationary power generation. After discussing the fundamental principles on which the turbine operates, the turbines are classified according to method of application, and following this, typical construction details are covered.

Lubricating requirements and how they are met in turbines are treated in some detail. Methods of estimating expected performance of turbines under different conditions are shown. A chapter on operation and maintenance discusses problems in running, starting and stopping a turbine. Also included are chapters on governing and turbine auxiliaries.

A final chapter on gas turbines recognizes the rapid rise of these units to a practical status during the past 10 or 12 years. The famous "bible" of the steam turbine, entitled, "Steam and Gas Turbines" (the same as the present book), was written many years ago by Dr. Stodola and covered the theoretical principles of the gas turbine, but at that time it was not possible to build practical gas turbines. Now, however, because of advances in the art of metallurgy and other factors, the gas turbine is going ahead rapidly. It is interesting that Dr. Stodola, before his death, was able to run a test on a practical gas turbine installation.

Before many years, the authors point out, the practical operating and plant designing engineer will have to be well versed in the fundamentals of gas turbines, as well as steam turbines.

The book is extremely well illustrated with diagrams and drawings and is well indexed. It is written in simple, direct language and is well suited for self study. All power engineers will find in it a great deal of helpful information about their principal prime mover.

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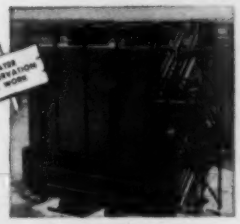

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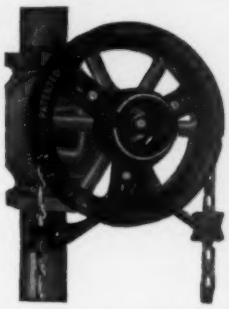

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POWER PLANT CONSTRUCTION NEWS

Anchorage, Alaska—Chugach Electrical Association, Anchorage, is projecting plans for new steam-electric generating station on site fronting on Alaska Railroad, near Anchorage. It will be equipped for a capacity of about 11,900-kw. Cost estimated approximately $5,250,000, including switching station and transmission line to Palmer and vicinity, where service will be supplied. Financing is being arranged through REA.

Bradenburg, Ky.—Mathieson Hydrocarbon Chemical Co., care of Mathieson Chemical Co., 610 Sharp St., Baltimore, Md., lately chartered as a joint interest of Mathieson company and Tennessee Gas Transmission Co., Commerce Bldg., Houston, Tex., plans power plant at proposed new factory near Bradenburg, where over 2000 acres of land has been secured, to be used for production of industrial chemicals of hydrocarbon base. It will comprise a large group of buildings. Entire project estimated to cost about $17,000,000. Completion is scheduled late in 1951.

Bay City, Mich.—Board of City Commissioners, City Hall, is considering a new municipal steam-electric power plant, reported to cost approximately $3,000,000, according to a preliminary estimate made by Ayres, Lewis, Norris & May, Ann Arbor, Mich., consulting engineers. A regular survey of city requirements will be made by latter organization for Commissioners, when so authorized in future.

Holland, Mich.—Parke, Davis & Co., Inc., Joseph Campeau Ave. and Detroit River, Detroit, Mich., pharmaceutical products, plans boiler plant at proposed new factory at Holland, where tract of about 27 acres of land has been purchased. It will comprise several buildings for processing and production. Entire project reported to cost approximately $1,500,000.

Albany, N. Y.—Niagara-Mohawk Power Corp., 300 Erie Blvd. West, Syracuse, N. Y., has preliminary plans under way for new steam-electric power plant on Hudson River, approximately 3 miles from Albany, with turbine-generators and accessories, high-pressure boilers and auxiliary equipment for large capacity. Cost reported close to $27,000,000, with switching station, transmission lines and other operations.

Syracuse, N. Y.—Niagara-Mohawk Power Corp., 300 Erie Blvd. West, is projecting plans for new hydroelectric generating plant on Sacandaga River, about 3 miles from confluence with Hudson River. Details and estimates of cost are being made. Application for authority has been made to Federal Power Commission, Washington, D. C.

Carlisle, S. C.—United Merchants & Manufacturers, Inc., 1412 Broadway, New York, N. Y., operating textile mills in different parts of country, plans boiler plant at proposed new finishing mill near Carlisle, where tract of land has been selected. It will consist of a number of buildings, equipped for large output. Entire project to cost over $1,000,000.

Charlotte, N. C.—Kroehler Mfg. Co., Naperville, Ill., furniture products, plans boiler plant at new one-story factory, about 76,000 sq ft of floor space at Charlotte. Entire project is estimated to cost approximately $550,000. Erection will begin at early date. J. N. Pease & Co., 119½ East Fifth St., Charlotte, is architect and engineer.

Greensboro, N. C.—Moses H. Cone Memorial Hospital, care of C. M. VanStory, Jr., executive director, plans central-heating plans and system in new multi-unit hospital on local site. Cost estimated close to $5,000,000. Proposed to begin work on project in July. Samuel Hannaford & Sons, Dixie Terminal Bldg., Cincinnati, Ohio, are architects.

Salisbury, N. C.—Empire Knitting Co., Statesville, N. C., plans boiler plant at new mill near Salisbury, where tract of about 12 acres of land has been secured. It will consist of two main units, close to 100,000 sq ft floor space. Entire project is reported to cost over $500,000.

Cincinnati, Ohio—Formica Co., 4620 Spring Grove Ave., laminated plastic products, etc., plans central heating-plant and system in new factory on Reading Rd. Initial unit will comprise about 100,000 sq ft floor space, and is estimated to cost about $1,000,000. Proposed future additions will make an estimated ultimate investment reported over $5,000,000.

Erie, Pa.—Pennsylvania Electric Co., Johnstown, Pa., nearing completion for new addition to steam-electric power plant at Erie, about 125 x 225 ft, with installation of turbine-generator, high-pressure boiler and accessories for increased capacity, with modernization and improvements in present station. Cost reported over $12,000,000. Gilbert Associates, Inc., 412 Washington St., Reading, Pa., is consulting engineer.

Cloverdale, Va.—Lone Star Cement Co., 342 Madison Ave., New York, N. Y., plans power house at new cement mill near Cloverdale, vicinity of Roanoke. It will comprise several large buildings for processing and production. Entire project is reported to cost about $6,000,000.

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Fig. 83

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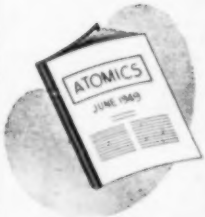

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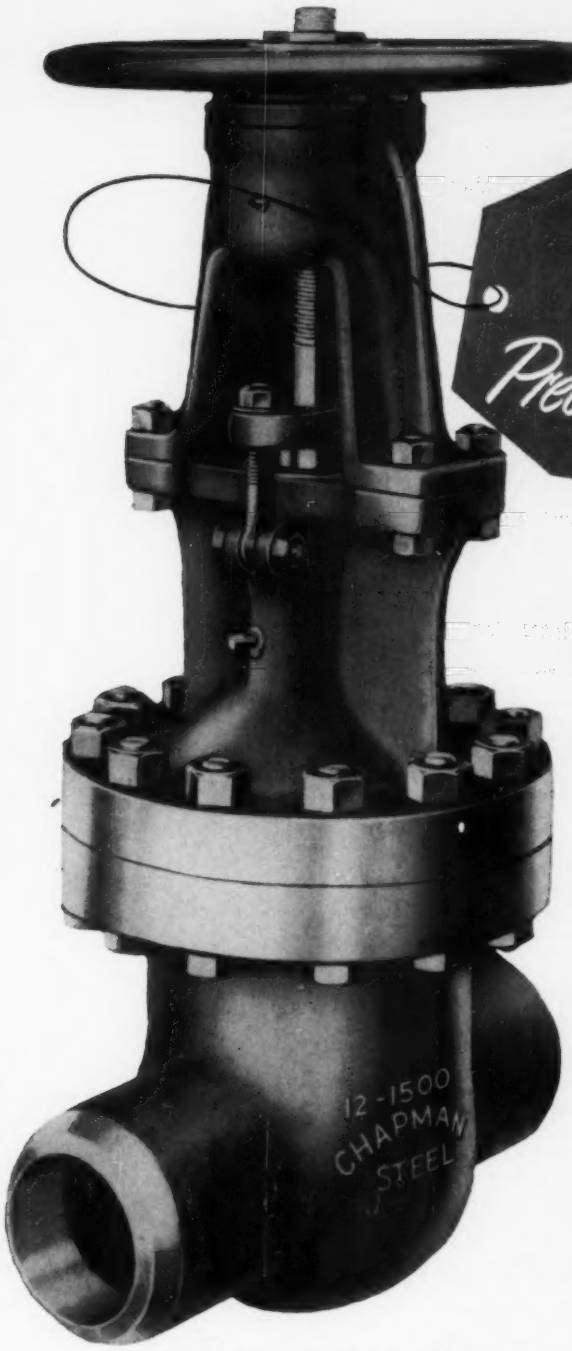

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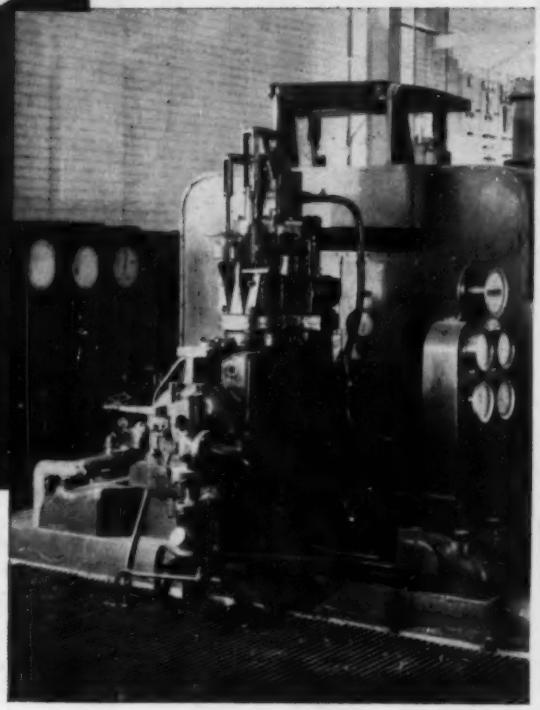

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